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MODERN LIME KILNS; THE PLANT OF THE KNICKERBOCKER LIME CO., MILL LANE, PA.

By REX C. WILSON.*

Common lime has for many centuries been one of the most important of building materials; but up to a very recent date it has all been produced in the same old-fashioned pot kilns of masonry that have been in use by lime burners from time immemorial.

Within the past half dozen years, however, the enormous increase in demand for lime, and particularly for lime of high grade, has led a number of progressive lime producers to set up kilns which are radical improvements over those of the older time.

An example of a modern lime-producing plant is that of the Knickerbocker Lime Co., at Mill Lane, Pa., which, so far as the writer's knowledge extends, is the largest and most modern lime-producing plant in the United States.

The plant is composed of a battery of six steel kilns each 18 ft. in diameter at the base, by 17 ft. in diameter at the top and 40 ft. high. Each kiln has a somewhat conically shaped cap 1 ft. 6 ins. high tapering from the round of the kiln to a rectangular charge door between track rails. There is walled in position, in foundations beneath each kiln, a heavy steel double cooler, made in two equal-sized extensions, placed one behind the other, in what is called the cooler pit. Each cooler is 8 ft. 3 ins. long, 5 ft. 2½ ins. wide and 8 ft. high, tapering to 3 × 3 ft. at the bottom. Each cooler extension is furnished with a heavy sliding double gate at the bottom. This is operated from the front of the cooler pit by a large hand wheel on a main shaft, which is geared to short transverse shafts by bevel gears. These in turn are fitted with pinions which mesh in racks on the underside of sliding gates, each of which is made in halves, the opening being made in the center of the bottom of the cooler extension. These gates are made to operate to a nicety, discharging a large or small amount of lime at the will of the operator.

The kilns are approached from the adjacent abutment on the right (Fig. 1) by means of a standard-gage track supported on a structure composed of latticed channel columns and I-beam girders, to which rails are bolted direct. The whole is braced laterally by angle-struts and ties, making a most substantial structure. The girder bridge, which is a part of the track structure, is of 50-ft. span. The two kilns nearest the abutment on the right and the two on the extreme left (Fig. 1) are operated with bituminous coal for fuel, the supply being dumped through chutes in the main track at the rear of plant and sliding thence to bunker storage behind the retaining wall at the rear of kilns close to their bases (Fig. 8). From here it is drawn from an opening in the wall for supplying the furnaces. The coal is fired by hand into furnace extensions, one on each side of each kiln at the base, through double counterbalanced drop doors, upon a grate-way 7 ft. long × 10 ft. wide (the furnace being 5 ft. high). The products of combustion, rising from a heavy bed of fuel, thoroughly united, pass upward over a low bridge wall, through the interstices of the descending lime stone which has been charged in the door at the top of the kiln. The heated gases travel on upward to the top of kiln and pass off through two horizontal side outlets on opposite sides of the kiln and enter the main horizontal flue, which conveys the spent gases to the bell-bottom stack, from which they are thrown off into the atmosphere. The coal furnaces are operated under forced draft, the pipe tuyeres from the blower entering immediately beneath the grates.

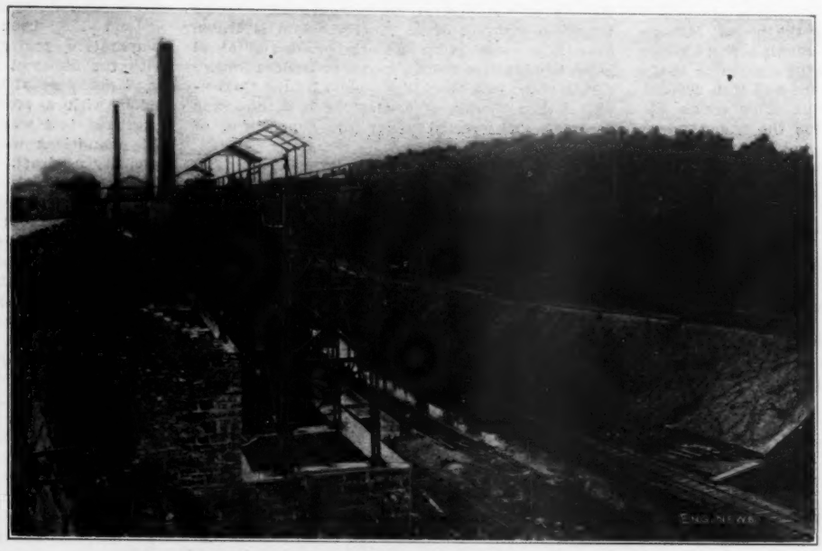

FIG. 7. VIEW OF KILN SUPPORTS, SHOWING COAL BUNKERS.

FIG. 8. VIEW OF SURFACE LIMESTONE QUARRIES.

The remaining two kilns are operated with producer-gas fuel, obtaining the supply from four producers of the coal-fired "Talbot" type (which has been found admirably adapted for this work) 10 ft. diameter and 15 ft. high, including the water pan. The arrangement of gas and solid fuel furnaces is shown in the same kiln cross section on Fig. 2 for comparison. It is obvious that both gas and solid fuel furnaces are not parts of the same kilns.

The gases are conducted from the producers by a horizontal main along the front of the kilns at the firing-floor level, thence under the firing floor and upward in front of each furnace extension, where the gas is discharged into the furnace through a jacketed, air-cooled, funnel-shaped burner.

*Engineer, Coatesville Boiler Works, Coatesville, Pa.

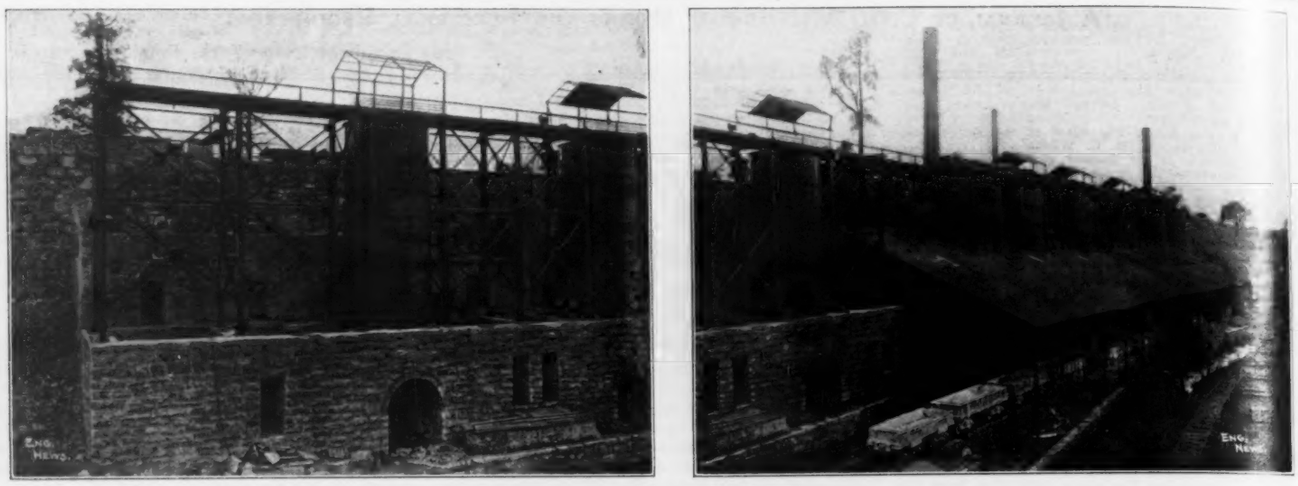

FIG. 1. GENERAL VIEWS OF THE BATTERY OF LIME KILNS, KNICKERBOCKER LIME CO., MILL LANE, PA.
(Same kiln shown twice in adjoining portion at center.)

After leaving the burner the gases are immediately ignited upon entering the heated furnace chamber. The gas passes through a short series of fire-brick checkers occupying the same space as the furnace in coal-fired kilns and then upward through the shaft of the kiln, after which the products of combustion pursue the same course previously described for the coal-operated kilns.

The quarried limestone (calcium carbonate) is conveyed from surface quarries near the plant to the structural approach over the top of the kilns in 8-ton, standard-gage, drop-bottom cars, from which it is dumped directly into the top of each kiln through the door opening between the rails. This door is covered by a sliding door operated from the side of the track by a rack and pinion with a hand wheel.

After passing downward through the kiln and being thoroughly burned, a condition that is determined by peak-holes at the base of the kilns, the finished product is drawn through the coolers at the base of the kilns and shoveled by hand directly into cars for shipment.

The operation of the plant is practically continuous as, each kiln being a unit, it is necessary to repair only one at a time and there is never more than one kiln out of operation at any one time.

The masonry and fire-brick lining in the kilns leaves a clear rectangular core-way 14 ft. 6 ins. long by 9 ft. wide, having the corners rounded to 18-in. radius. The limestone in passing from the top of the kiln to the bottom of the cooler travels a distance of 62 ft. Each kiln is drawn four times every 24 hrs. and the product obtained is practically free from all core or useless lime.

This plant was erected complete by the Coatesville Boiler Works, of Coatesville, Pa., and was designed and erected under the supervision of the writer.

A COMPARISON OF THE RESULTS OF 400 BOILER TESTS WITH COALS FROM VARIOUS PARTS OF THE UNITED STATES.

In Bulletin No. 325, issued by the United States Geological Survey, is a lengthy detailed discussion of 400 steaming tests made on two hand-fired Heine water tube boilers, by the boiler division of the U. S. Geological Survey's fuel testing plant at St. Louis. The fuels compared have been collected from all the prominent fields of the United States. It is stated that the comparison has been made by determining the evaporative performance of these two boilers with the different coals and lignites. All tests were made at about the rated capacity of the boiler with a steam pressure of 80 lbs. The length of test was ten hours. The only variable conditions were thickness of fuel bed and intensity of draft.

Several general conclusions were drawn from a comparison of these 400 tests, among which may be mentioned:

(1) Except in extreme cases the combined boiler and furnace efficiency was little affected by the actual temperature of combustion.

(2) High C O_2 content in the flue gases is not

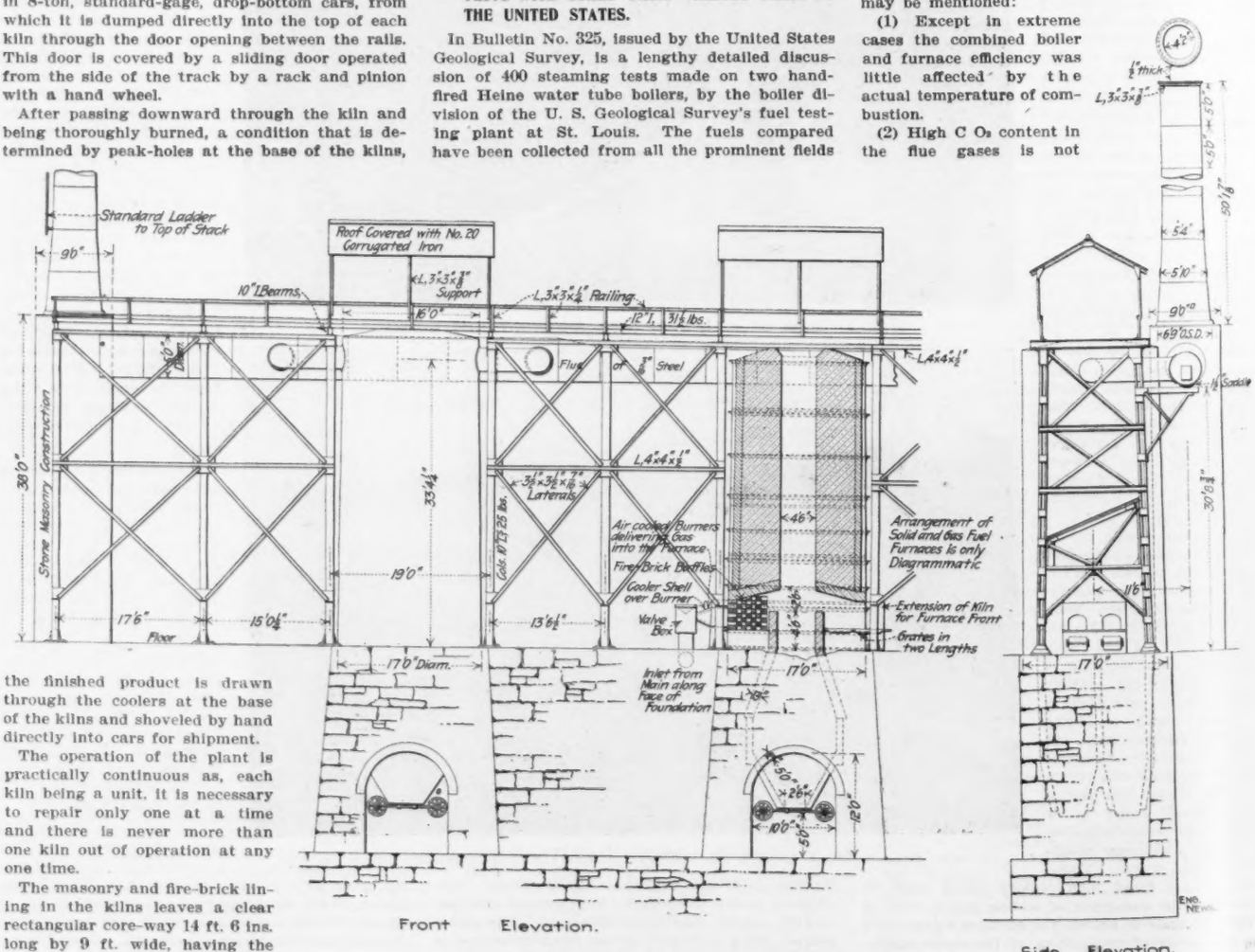

FIG. 2. SECTIONAL AND SIDE ELEVATION OF STEEL LIME KILN, SHOWING THE GENERAL ARRANGEMENT OF GAS AND COAL-BURNING FURNACES.

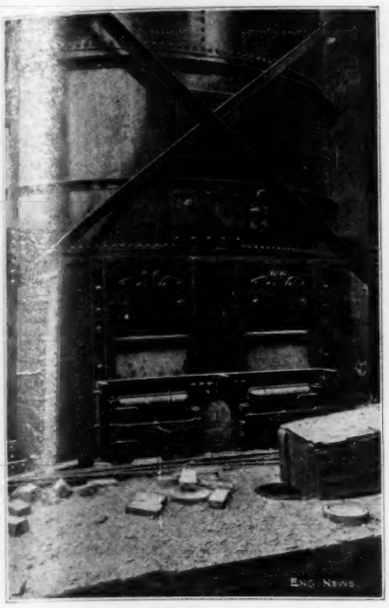

Fig. 3. Furnace Extension on One Side of Gas-Fired Kiln.

a definite indication of a high combined efficiency. Best efficiencies were obtained with about 10% C O₂.

(3) High C O was always a definite indication of low combined efficiency. Such a high percentage itself accounted for only a small part of the loss but indicated poor furnace conditions whereby other combustible gases passed up the stack.

(4) The rate of coal combustion was affected by the chemical composition of the fuel, by the intensity of draft and, to a lesser extent, by the thickness of fire and the formation of clinker. Bituminous coals high in volatile matter burned more quickly than those high in fixed carbon. Coal in sizes from ¼ to 1½ ins. burned much more rapidly than either smaller or larger sizes.

(5) Capacity varied almost directly with the rate of combustion. Extremely high or low capacities were attained at reduced efficiencies.

(6) Ash, in dry coal, up to 15% did not appreciably lower capacity or efficiency.

(7) Moisture reduced somewhat both capacity and efficiency.

(8) Sulphur was not detrimental to the steaming value of coals except as it existed in such compounds that it formed, with other ash constituents, a fusible clinker which adhered to the grates.

(9) Most coals when briquetted could be burned at a higher rate of combustion with little or no smoke.

(10) Washed coal could be burned at a higher rate of combustion, though the washing did not decrease the percentage of black smoke produced. Boiler and furnace efficiency were not increased by washing coal except with coals of high ash content and much free pyrites.

(11) Bituminous coal was best fired in small quantities every three or four minutes on one-half the grate area at a time. Up to a medium rate of combustion all smoke was avoided by leaving the furnace doors partly open for a short time immediately after firing. The best thickness of fire was from 5 to 10 ins. with a draft pressure of 0.5 to 0.7 in. under the stack damper.

(12) Good results were attained with lignites when a difference of draft was obtained, between stack and ash pit, of 1½ to 2 ins. The fuel was best fired then in large amounts every six or eight minutes by spreading. Rocking grates were recommended for use with lignites.

Fig. 4. Cooler Gate in Place.

(13) With hand firing, a furnace having a tile roof and a large combustion chamber with good mixing structures, was recommended for burning bituminous and lignitic coals.

Much of this bulletin is taken up with a discussion, largely theoretical, of new ways of determining true boiler efficiency and of the absorption of heat in boilers. The preliminary work on these deductions was outlined in a previous issue of this journal (Engineering News, July 11, 1907) and, as there is little intimate connection with the practical matters of coal burning given in this article, a discussion of these theoretical deductions is not included herein.

A 9,700-HP. HYDRAULIC TURBINE of the Francis type, built by the Allis-Chalmers Co., of Milwaukee, Wis., has been placed in service at the Centerville plant of the California Gas & Electric Corporation. This is claimed to be the first Francis wheel to operate on a head as high as 550 ft. A governor-operated relief valve installed discharges 190 cu. ft. of water per sec., suddenly turned off from the turbine by the governor, without exceeding a pressure rise of 7½% above the normal pressure in the pipe line. Only early tests have been reported, but these are stated to show high efficiency and smooth running.

DREDGING COSTS ON THE ST. LAWRENCE RIVER AND IN OTHER PARTS OF CANADA.

By EMILE LOW,* M. Am. Soc. C. E.

THE ST. LAWRENCE SHIP CHANNEL.

Out of the 220 miles of the ship channel of the St. Lawrence River which lie between Montreal at its head and the Traverse near the mouth, there are about 70 miles which were originally in need of improvement in order to give a minimum depth of 30 ft. and a width of 450 ft. on tangents and from 500 to 750 ft. on curves. Of these 70 miles, 56 miles have already been dredged in that portion where the tide is not available, so that with the help of the tide for a short distance, a 30-ft. depth is now obtained all the way from Montreal to Quebec.

From now on the work will be concentrated toward obtaining a greater width in Lake St. Peter, and the tidal parts of the river, as well as the full depth of 30 ft. at low tide. About an equal amount of work is yet to be done above and below Quebec. Up to this date 48,037,670 cu. yds. of material has been dredged, and it is estimated that 17,385,000 cu. yds. are yet to be dredged, which will give a total of 65,422,670 cu. yds., a very formidable quantity of material.

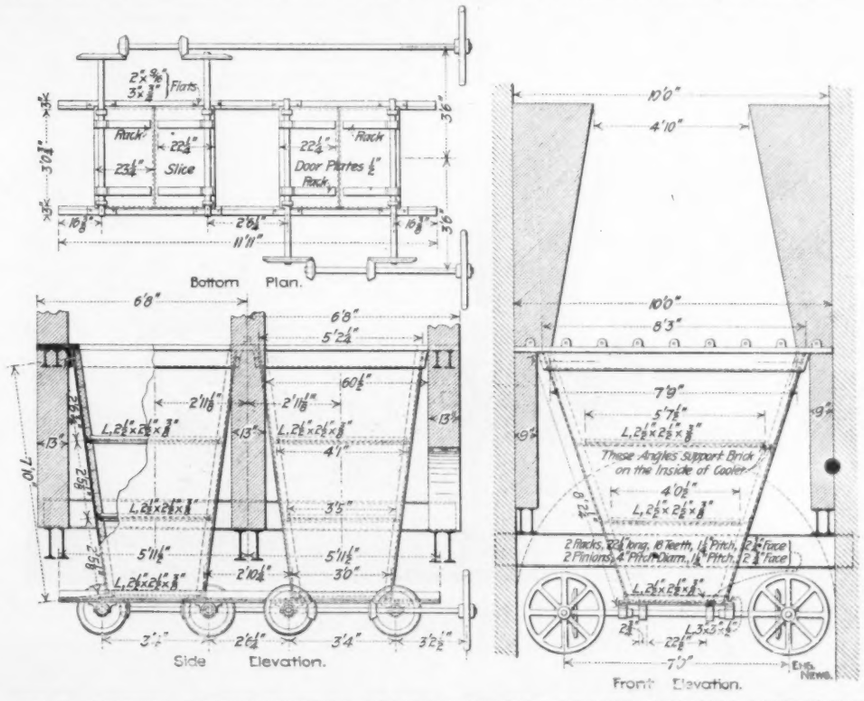
Bottom Plan.
Side Elevation.
Front Elevation.
These Angles Support Brick on the Inside of Cooler.
Door Plates ½"
Flats
Rack
Slice
2 Racks, 22½" long, 18 Teeth, 1½" Pitch, 2½" Face
2 Pinions, 4" Pitch Diam., 1½" Pitch, 2½" Face

FIG. 5. GENERAL ARRANGEMENT OF COOLER EXTENSION OF LIME KILN; MILL LANE PLANT, KNICKERBOCKER LIME CO.

The St. Lawrence is different from most rivers in its bank and bottom conformation. Usually a river has at its source steep slopes which tend to erode the banks and to transport coarse and heavy material. As the slope becomes more gradual, this erosion decreases until at the mouth of the river the water carries in suspension a fine sediment which deposits, to the great detriment of navigation. In the St. Lawrence the material from most of the sources of supply is all deposited in the settling basins. From the lakes to the ocean the bottom of the river is usually hard, so that there is not only clear water, but a permanent river bed.

The nature of the material composing the bottom of the river, though in many places very difficult to dredge, is for the same reason of such a character that a dredged cut once made is substantially permanent.

In the ship channel the material to be excavated varies from soft blue clay into which a pole may be planted some 6 to 7 ft. by hand, to stiff clay, to hard pan as hard as a macadamized road, to shale rock and large boulders. In one

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or two localities coarse sand is found, at which points dredging has to some extent to be repeated. Below Quebec, at the localities where the fresh and salt waters meet, there are the usual sand bars, but these do not seem to be increasing. The movable nature of the material, added to the lack of uniformity of the tides, currents and salt water, results in more unstability in the shoals below Quebec. It is therefore expected that the maintenance of the excavated channels, there, will require some annual re-dredging. The currents of the St. Lawrence are, for a river of such size, not only reasonable and regular, but altogether free from the usual dangers to navigation resulting from freshets. Except for floods during the ice accumulations, the fluctuations in level are gradual and not excessive. The winter season, with its ice and snow, is the one great drawback to the St. Lawrence.

The improvement of the St. Lawrence is one of the great works of the world. It was begun in 1844, the first dredge machinery being built in Glasgow, Scotland. A dredge in 1846 excavated in Lake St. Peter, in one day 1,200 cu. yds. By wonderful improvements in plant, in 1888 a dredge would excavate 7,200 cu. yds. without trouble, and in 1906, working day and night, 20,000 cu. yds. was a frequent day's work.

The following statement gives the dredging plant now owned and operated by the* Department of Marine and Fisheries, Canada, in connection with the River St. Lawrence Ship Channel: 6 elevator dredges; 1 hydraulic dredge, with 23 pairs of pontoons for floating pipes and 2 winch scows; 1 suction hopper dredge; 1 ice breaking and sweeping tug; 12 towing tugs; 4 coal barges; 2 stone lifters; 1 sounding scow; 1 coal scow; 6 house boats, and 14 hopper scows. Of the elevator dredges four have hulls of wood, the other two have steel hulls. The buckets are generally cast steel, especially designed for working in rock or other hard material. On the division between Batiscan and Quebec, most of the excavation is in solid shale rock. In consideration of the fairly soft character of the shale rock, the elevator dredge is by far the most economical and efficient machine known to dredge it. The one hydraulic dredge in use is the well-known "J. Israel Tarte," fully described in Engineering News of July 28, 1904. The St. Lawrence at Lake St. Peter widens out into a shallow water lake, about 9 miles wide and 22 miles long. The material is almost all soft blue clay of the consistency of ordinary table butter. A bank made almost vertical will remain for years. There is practically no filling in, but the wash of the propellers deepens the center of the channel slightly, and deposits it near the south bank. It was in this material that the dredge "J. Israel Tarte" excavated 1,984,510 cu. yds. during the fiscal year ended June 30, 1906, at a cost of $117,668.03, or an average of 5.92 cents per cu. yd. The average hourly rate of dredging was 1,000 cu. yds.

The dredges are operated 132 hours per week, or steadily from midnight on Sunday until noon on Saturday. Stops are only made for repairs, for shifting from one place to another, bad weather, or to give room for passing vessels. Coal is supplied by barges without stopping the work.

The constant steady work in exceedingly hard material at a depth of from 32 to 42 ft. is very hard on machinery. Only the very best designed and well constructed plant can stand it. Traffic must not be interrupted and the work must always be carried on in the more or less swift current. The material is increasing in hardness from year to year, as the work nears Quebec. All the soft material except the remainder of the work in Lake St. Peter, is now completed. A dredge that can remove 6,000 cu. yds. per day in soft material, without trouble, is more fatigued by dredging 1,000 cu. yds. of hard pan, in which boulders are imbedded.

*Compiled from report of Marine and Fisheries, Canada, F. W. Cowie, Superintending Engineer, Ottawa, Ontario.

TABLE I.—SHOWING DREDGING ACCOUNTS ON ST. LAWRENCE RIVER DURING FISCAL YEAR, 1905-06.

Name of dredge	Laval.	Laurier.	Lady Aberdeen.	Lady Minto.	La Fontaine.	Baldwin.	J. Israel Tarte.	Total excavation by 7 dredges.	*Average cost per cu. yd. in cts.
Material	Hard-pan, stones, and shale.	Clay and sand, sand and stones.	Sand, hard clay and stones.	Variable.	Hard clay and stones.	Clay, sand and stones, hard clay.	Soft blue clay.		
Kind of dredge	Elevator	Elevator	Elevator	Elevator	Elevator	Elevator	Hydraulic		
Year built	1894	1897	1900	1900	1901	1902	1902		
Length over all, ft.	150	168	148	148	168	165	160		
Beam, in ft.	30	32	32	32	32	34	42		
Depth of hold, in ft.	14	14	13	13.0	14	14	12.5		
Average draft, in ft.	11	10	8.5	8.5	9	8	6		
Greatest working depth, ft.	43.5	42.5	42.5	42.5	45	45	50		
Costs in percentage of totals:								Average percentages.	
Fuel	14.1	12.7	14.8	11.8	14.8	13.0	25.6	16.9	1.8
Wages	14.3	14.4	12.7	13.9	11.0	12.8	11.4	12.7	1.5
Board	5.0	5.2	5.5	5.0	4.7	4.6	3.6	4.6	0.8
Stores	3.5	4.5	4.6	4.7	3.9	3.7	9.1	5.5	0.8
Repairs	23.0	18.8	17.3	23.0	21.0	22.3	13.6	18.9	1.9
Percentage of general expenses	10.4	9.6	9.3	10.2	9.6	9.7	11.0	10.1	1.08
Stone lifters	1.2	1.3	1.3	1.2	1.1	1.1	0	0.9	0.09
Tug service	15.8	20.5	20.8	17.5	22.4	21.3	14.8	18.3	1.94
Inspection and towage	12.7	13.6	13.7	12.7	11.5	11.5	10.9	12.1	1.27
Total costs of operations in $.	50,828	49,255	46,887	50,740	55,736	55,641	117,668	426,755	
Material excavated, cu. yds.	144,000	408,350	270,700	278,650	213,600	747,720	1,984,510	4,047,530	
Cost per cu. yd., in cents.	35.29	12.06	17.32	18.20	26.09	7.44	5.92	10.54	10.54
Time of service, days.	185	185	180	184	185	186	160	.....	
Nominal working time, in hrs.	4,068	4,068	3,960	4,044	4,068	4,092	3,556	.....	
Hours actual dredging.	2,532	2,543	2,752	2,670	2,883	3,040	1,985	.....	
Number of scows filled.	906	1,899	1,353	1,393	712	2,497	.....	.....	

*This column not in percentages, but in cts. per cu. yd.

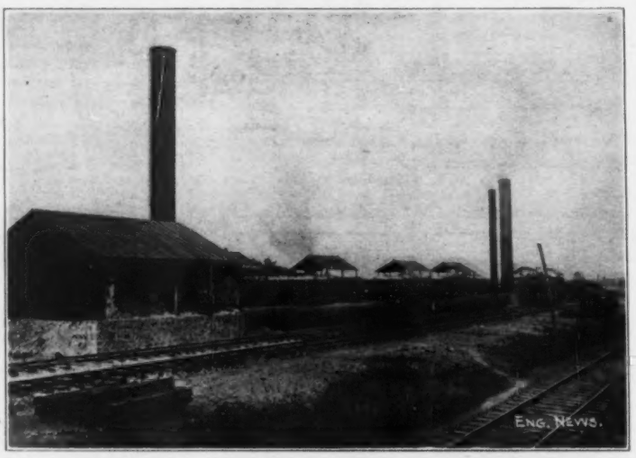


FIG. 6. VIEW OF KILNS AT MILL LANE, PA., SHOWING HORIZONTAL FLUES FROM KILNS TO STACKS.

About 400 men are employed in connection with the dredging operations. These men, all sailors, were born and brought up at Sorel or at some of the parishes bordering on the River St. Lawrence. Most of them have been trained to the service from boyhood. A captain and an engineer are in general charge respectively of the vessel and machinery. The remainder of the crew is divided into two watches and works in shifts of 6 hrs. At noon on Saturday the work stops. Only two holidays, Dominion Day and Labor Day, are given throughout the season. The boarding of the men is done by contract with the captain of the vessel, at so much per man.

In making up the cost of the work of dredging, everything is included, except interest on the capital expenditure and depreciation. The principal items of cost are wages, fuel, board, stores and repairs, as well as general expenses and superintendence. The item of repairs includes keeping the plant in constant good order, but does not include new improved machinery.

In the accompanying table (Table I.) there is given a full account of the costs of the dredging on the ship channel for the year ending June 30, 1906. In this table the various items making up the costs are recorded as percentages of the total, so as to give an opportunity for comparison between the various dredges. The last column gives the average unit cost for the various items in cents per cubic yard.

A complete description of past dredging work on the St. Lawrence may be found in the Transactions of the American Society of Civil Engineers, v. 54, Part C, p. 276.

THE MARITIME PROVINCES AND ONTARIO AND QUEBEC.

In Tables II and III there is given a condensed record of the dredging operations carried on by the Canadian Department of Public Works in the Maritime Provinces (Nova Scotia, New Brunswick and Prince Edward Island) and in Ontario and Quebec, during the fiscal year 1905-06. The tabulation has been made, in a similar manner to

TABLE II.—SHOWING DREDGING ACCOUNTS IN THE MARITIME PROVINCES OF CANADA DURING FISCAL YEAR 1905-06.

Name of dredge	St. Lawrence.	Canada.	New Dominion.	Prince Edward.	George McKenzie.	Cape Breton.	New Brunswick.	W. S. Fielding.
Material	Boulders gravel, sand, stone, clay, mud, stumps and slabs.	Gravel, stone, mud, sand, sawdust.	Boulders, clay, gravel, mud, sand.	Clay, sand, mud.	Gravel, clay, sand, mud.	Boulders, mud, gravel, sand, clay, logs.	Mud, gravel, clay, sand, logs.	Mud, gravel, rock, clay, sand.
Kind of dredge	Self-propelling elevator	Self-propelling elevator	Dipper	Dipper	Dipper	Boom & dipper	Clam shell	Elevator & hydraulic
Length over all, ft.	175.0	130.0	90.0	80.0	90.0	91.0	90.0	250.0
Beam, ft.	30.0	20.0	28.0	28.0	28.0	36.0	25.0	42.0
Draft, ft.	8.5-13.5	7.0-11.5	5.5	6.0	6.0	7.5	2.5	18.0
Working depth, ft.	8.5-28.0	7.0-16.0	21.0	21.0	22.0	34.0	17.0	60.0
Costs in percentage of total:								
Fuel	14.5	15.3	5.1	3.3	3.5	4.8	7.1	25.1
Wages	39.1	34.5	29.4	28.0	25.0	23.3	33.0	41.6
Provisions	9.9	11.2	4.9	6.9	6.1	6.6	7.5	8.0
Stores	1.3	3.2	1.7	3.5	1.2	1.5	1.4	3.1
Equipment	1.4	1.3	2.3	0.4	6.9	7.5	2.1	0.3
Water	0.4	1.0	2.2	0.4	5.7	0.4	1.1	0
Repairs	21.4	25.7	10.4	15.9	3.1	10.5	12.8	3.5
Pilotage	5.8	2.0	0.1	0	0	0	0	1.6
Towage	0.1	0	39.0	35.7	21.2	39.9	30.0	11.6
Wharfage	0	0.7	0	0.6	0.2	0.2	0	0
Contingencies	1.3	0.5	0.1	0.6	0.5	0.5	0.2	0.4
Not specified	4.8	4.6	4.8	4.7	26.5	4.8	4.8	4.8
Total costs in dollars.	12,885.26	13,546.02	15,451.96	17,680.96	15,991.81	17,382.62	11,188.04	15,961.57
Material excavated, cu. yds.	55,788	51,745	64,185	60,682	42,887	126,770	70,880	83,449
Cost per cu. yd., in cents.	23	26	24	29	37	14	16	19

that in Table I, from information in the last annual report of the* Minister of Public Works.

The short time that the dredges are actually at work during the year should be noted. They are laid up during the winter months, usually January, February, March and April, and sometimes during December. On a basis of a ten-hour day, the eight dredges recorded in Table II only worked 589 days, or an average of 73½ days each during the entire year, or about 3 months, thus being idle the remaining 9 months. The actual cost of the dredging at the localities where it was done, was $79,751.05, the expense for wintering, repairs, equipment, and superintendence was $40,321.19, making the total as given $120,072.24, the average cost per cu. yd. in the former case being 14.33 cents and in the latter, 21.58 cents.

As the report does not give the time actually engaged in dredging, no compilation can be made showing rate per hour, nor actual cost while on the work for the operations reported in Tables II and III.

The following memorandum shows the wages paid the crew of the dredge "Ontario."

Captain and engineer in charge	$100.00 per month
Cranesman	50.00 "
Fireman	35.00 "
Deckhands	30.00 "
Scowman	30.00 "
Tug wheelsman	60.00 "
Tug engineer	50.00 "
Tug fireman	35.00 "

ERECTION OF THE LONG PLATE GIRDERS OF THE TOWANDA BRIDGE.

In our issue of March 14, 1907, we described the general layout of the new grade and alinement work on the Lehigh Valley R. R. at Towanda, Pa., the main part of which consisted in the erection of a 14-span plate girder bridge across the Susquehanna River. At the time of the publication of the previous article the girders had not been erected and a description of their make-up and method of erection was necessarily omitted. The bridge is now completed and in operation. The composition of these plate-girders—among the largest ever built in this country—and the method of their erection are treated in this article.†

The girders to this bridge comprise 14 skew, double-track, deck spans, 12 of which are 129 ft. 6 ins. total length and two of which are smaller. Each track is carried on a separate pair of girders, each pair latticed together to form an independent structure. They were designed for a load of two 177.5-ton locomotives followed by a load of 5,000 lbs. per lin. ft., with a dead load in the large spans of 2,600 lbs. per lin. ft. The bottom laterals were designed for a wind stress of 300 lbs. static and 366.5 lbs. per lin. ft. for moving loads on those spans which are on curves; the top laterals for 600 lbs. static, 450 lbs. moving, with 366.5 lbs. per lin. ft. on curves. The maximum chord stresses are 656,000 lbs. live and 133,700 dead load, a total of 792,000 lbs., and the maximum end shear 226,400 live and 82,200 dead, or a total of 308,600 lbs.

Each of the large girders is 129 ft. 6 ins. long from end to end and 126 ft. 6 ins. from c. to c. of bearings and is built with a chamber of ¾-in. The weight of each is 56 tons. The general make-up consists of two 8 × 8 × ¾-in. angles for each flange, a $^{9}/_{16}$-in. web, two cover plates $^{9}/_{16}$-in. thick and two ½-in. thick for each flange, diminishing in length from the full span to a maximum of 48 ft. The end stiffeners are made up of 6 × 4 × ½-in. angles and the intermediate stiffeners of the same size, together with 6 × 4 × $^{7}/_{16}$-in. angles. The details of the design are well illustrated on Fig. 2.

Fig. 3 shows the traveler which was used on the work. It consists of two Warren single-intersection trusses, 147 ft. long, built to the same skew as the bridge. It travels on two sets of wheels at its rear end and at its three-sevenths point upon tracks laid upon stringers on the girders already in place and riveted and connected the traveler was moved forward and the erection continued as before.

We are indebted for the information herein presented to Mr. John Sterling Deans, Chief Engineer of the Phoenix Bridge Co., the contractor who designed and erected the superstructure of the bridge.

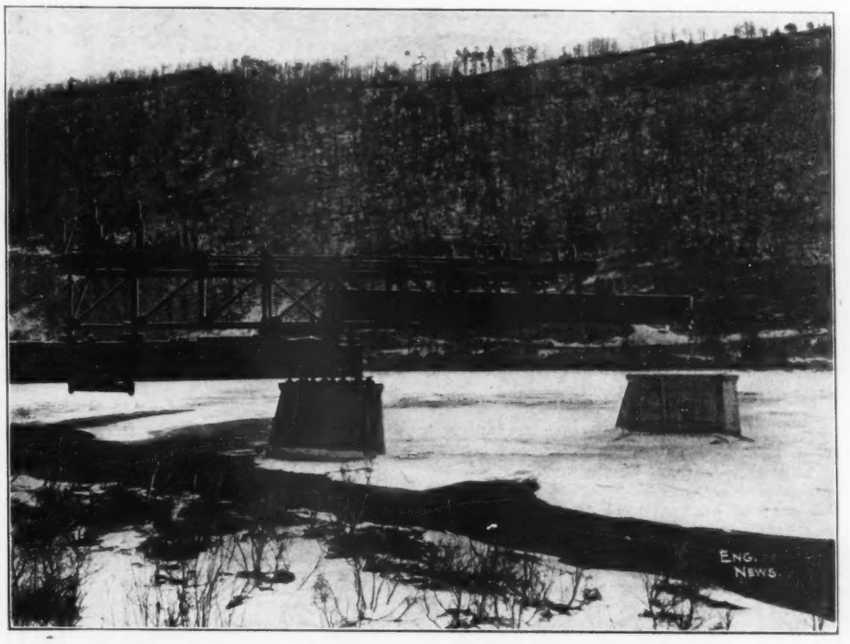


FIG. 1. OVERHANG TRAVELER ERECTING 130-FT., 56-TON PLATE GIRDER ON BRIDGE ACROSS SUSQUEHANNA RIVER, TOWANDA, PA.

up. Upon its upper chord there are three sets of supports for the girders; a stationary support at each end and a moving support between the two. At the rear end an anchorage is placed through the girders and fastened by a cross-beam to their lower flanges. In erecting the first span the overhang of the traveler was supported from the river bed by piles. In the other spans the traveler was run out until the outer wheels were over the outer end of the girder, the anchorage tightened and the wheels blocked tight as shown on the figure. The girder to be erected was then carried by a train out under the traveler and picked up by the moving carriage and carried by this and by the outside lifting hooks to the correct lateral position. The girder and traveler in this position are shown in Fig. 1. The girder was then lowered into position. When all four girders for one span were

*Also Report of Department of Public Works, Eug. D. La Fleur, Chief Engineer. Tabular matter greatly rearranged and augmented by adding "Costs in percentage of total." Figures checked and errors corrected by author.

†See Engineering News, Feb. 18, 1904, p. 166, for description of a 132-ft. plate girder.

ANNUAL CONVENTION OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The 23d annual meeting was held at the University of Illinois Jan. 15, 16 and 17. Nearly 60 members were registered.

The first meeting was called to order by the President, Mr. C. B. Burdick, at 2 p. m., Jan. 15, when an address of welcome was delivered by Mr. W. F. M. Goss, Dean of the College of Engineering. The President then read the annual address. He took as his subject "The Value of the Exchange of Ideas," showing the important developments resulting from one man imparting his own ideas and knowledge to others, and in return absorbing the information already imparted by others. This train of thought was followed to the development of technical literary work and the advantages of an engineering library, both to the student and to the practising engineer or investigator.

WATER SUPPLY.

A paper by Prof. C. W. Lawrence (James Milliken University) dealt with "Stream Pollution and Laws for Its Prevention," taking the Passaic, Allegheny and White rivers as strong examples of polluted streams. In regard to sewage pollution, the author stated that the greater

TABLE III.—SHOWING DREDGING ACCOUNTS IN ONTARIO AND QUEBEC DURING FISCAL YEAR, 1905-06.

Name of dredge	Challenge.	Nipissing.	Ontario.	Queen.	Mattawa.	Sir Richard.	Richelieu.	Nithsdale.	International.	Progress.	No. 6
Material	Rock, gravel, boulders and clay.	Clay, sand, mud, boulders, hard pan and quicksand.	Sand, clay, and quicksand.	Clay.	Quicksand, clay, and sand.	Sand, mud, clay, boulders and gravel.	Hard pan, clay, sand, boulders.	Clay, stones, sand.	Hard pan, clay, boulders, sand.	Sand, boulders, hard pan and clay.	Silt, clay.
Kind of dredge	Dipper	Dipper	Dipper	Dipper	Dipper	Dipper			Dipper		Dipper
Length over all, ft.	70.5	70.7	75.0	65.3	75.0	80.0	70.0	....	109.6	90.1	97.0
Beam, ft.	25.0	25.0	25.0	25.0	28.0	22.0	....	....	41.0	39.2	36.4
Greatest working depth, ft.	21.0	20.0	22.0	17.0	25.0	22.0	....	....	60.0	30.0	35.0
Costs in percentage of total:											
Coal	11.1	21.4	13.8	16.4	10.9	18.7	13.6	1.8	28.6	16.1	6.3
Wages	50.6	45.8	49.9	50.4	46.0	43.1	56.5	19.1	36.3	37.6	57.4
Provisions	15.9	10.3	13.7	13.9	9.8	10.7	12.7	6.0	9.8	10.0	19.4
Stores	1.9	4.6	3.6	4.4	3.6	2.8	3.8	2.1	0.8	2.6	3.3
Equipment	1.4	9.1	3.2	0.6	1.0	0	0.1	0	1.6	7.2	0
Repairs	17.3	8.1	12.5	11.9	16.2	22.3	12.1	0.5	17.2	26.3	12.5
Towage	0.4	0	0	0.6	3.6	0	0.3	11.2	3.2	0	0.5
Contingencies	1.4	0.7	3.3	1.8	8.9	2.4	0.9	59.3	2.5	0.2	0.6
Total costs in dollars	5,258.88	7,213.24	7,650.41	8,507.56	10,123.42	6,984.64	6,724.25	13,778.40	17,696.41	15,517.92	4,117.61
Material excavated, cu. yds.	32,050	61,012	53,550	34,753	29,500	72,100	37,655	18,240	64,500	62,780	7,400
Cost per cu. yd., in cents	16	12	14	24	34	10	18	76	27	25	56

number of legal decisions on this phase of the subject indicate that a municipality has no greater rights than a private owner, and that legislative action can do no more than authorize the municipality to acquire the rights of lower owners by purchase or condemnation. The laws of some states simply forbid poisoning or gross pollution, but do not recognize pollution by sewage or factory refuse. Others have laws which are general in their restrictions but do not provide any specific method of accomplishing their purpose. A third group have laws with specific and severe restrictions, while water supply and sewage works are under the control of the state board of health. A paper on "Experiences in the Operation of a Mechanical Filter Plant" was read by Mr. C. H. Cobb (Kankakee), and is abstracted on another page of this issue. Mr. H. M. Ely (Chicago) described "The 73d St. Tunnel, Chicago," this being part of the new system of water tunnels recently described in Engineering News. Mr. Bartow, Director of the Illinois Water Survey, also gave a talk on "Municipal Water Supplies from Streams in Illinois."

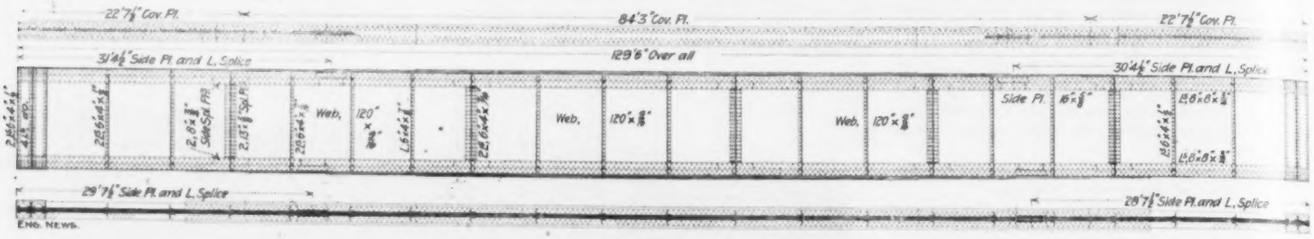

22'7⅞" Cov. Pl.
84'3" Cov. Pl.
22'7⅞" Cov. Pl.
3/4½" Side Pl. and L. Splice
129'6" Over all
30'4½" Side Pl. and L. Splice
Web, 120" × ⅜"
Web, 120" × ⅜"
Web, 120" × ⅜"
Side Pl. 16" × ⅞"
29'7⅛" Side Pl. and L. Splice
28'7⅛" Side Pl. and L. Splice
ENG. NEWS.

FIG. 2. DETAILS OF 130-FT. PLATE GIRDER FOR TOWANDA BRIDGE.

SEWERAGE.

The city of Cairo, Ill., is on low ground, protected from flood waters by levees, and Mr. W. B. Thistlewood, City Engineer, described the systems of drainage and sewerage. At first, the flood waters were allowed to escape through gates in the levees, but for the past ten years pumps have been used. These are of the Menge type used on irrigation works, and the two pumping plants have a capacity of 1,250,000 gals. per hr. For the sewage, a trunk sewer 4 to 6 ft. diameter and 9,000 ft. long is being built, closed by a 6-ft. flap valve or check valve at the Ohio River outlet. This serves the system of pipe sewers for storm water and house sewage. During high water periods the sewage will be discharged by pumping. A considerable amount of work is being done in raising the streets of the low-level parts of the city. This has been done by teams and dump cars, but a local company is now using the hydraulic dredge system. This costs the city from 28 to 32 cts. per cu. yd. A paper on "The Cost of Constructing Pipe Sewers" was read by Mr. G. C. Habermeyer (Elgin). Mr. A. B. Alexander, City Engineer of Decatur, Ill., presented a paper on the new reinforced concrete sewers of that city; these are now under construction and range from 3 ft. to 5 ft. in diameter. Some extracts from this paper are given below:

The depth of the trench varies from 8 to 20 ft., or an average of about 13 ft. The contractor first used teams and scrapers to excavate the upper 5 ft. in depth, the balance being done by hand. Then a Parsons trenching machine was put on the work, which proved to be a great success. As this will only cut to a depth of 20 ft., a Potter trenching machine was put on to follow up the Parsons machine, and the trench brought to grade with it. But as this latter machine requires the buckets to be filled by hand, the work progressed much slower than where all of the dirt could be handled with the Parsons excavator.

The material was a loose black soil for a depth of about 4 ft., the rest being clay with some sand and gravel (water bearing), for about 2 or 3 ft. from the grade line. The water was easily handled with a steam pump. After the trench was properly graded, using templates to get proper form, the concrete invert was laid and allowed to set. This took about 24 hrs., during the warm weather. Then the arch was put on, and about the same length of time allowed for it to set before the forms were removed, but after the weather got cooler it would take considerably more time for the concrete to set. The Blaw collapsible steel centers were used on all three contracts. While the specifications allowed either wood or steel centers, all of the three contractors figured that steel would be cheaper. It is not necessary to plaster the inside of the sewer after the steel forms are removed, as the finish will be smooth and glassy if the concrete is properly put in.

The thickness of the shell is 1 in. for each foot in diameter, plus ½ in. for the entire diameter. The mixture is 1 part Portland cement to 5 parts of well selected bank-run gravel, no gravel being larger than will pass through a 1-in. ring. The concrete for the invert was put in wet, in fact, it was floated in. Our experience taught us that otherwise the concrete would be honeycombed and porous. The concrete for the arch was made just wet enough so that it would not run or slip off the forms. The reinforcement on all of the sewers is expanded metal. On all sizes over 48 ins. a 3-in. mesh, No. 10-gage, was used, and on all sizes under 48 ins. a 2½-in. mesh, No. 16 gage, was used. The metal was cut in sheets 8 ft. long by half the circumference of the sewer, plus 12 ins. for the invert, which would give it a lap of 6 ins. on each side at the springing line. The metal for the arch was cut in sheets 8 ft. by half the circumference of the sewer. All metal was placed 2 ins. from the inside face.

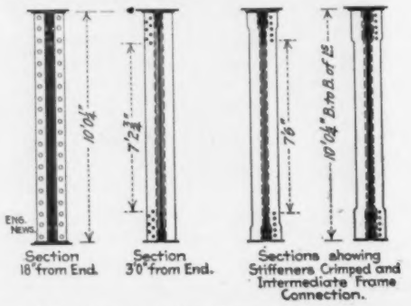


Fig. 2 (a). Sections Through Girder.

ROADS AND STREETS.

The report of the Committee on Roads and Pavements, presented by Mr. J. A. Moore (Chicago), referred to the defective conditions of roads and road administration in the central western states. It suggested that for rural communities a law somewhat similar to the district drainage law is desirable, and the vehicle tax law might also be applicable. The greater part of the construction work should be done by contract under engineering supervision, and the county should pay a large proportion of the cost, the remainder being assessed against the abutting property. For street paving, brick continues to be popular in the smaller cities. This is not the case in Chicago; where brick has been proposed (except for alleys) the property owners have frequently protested and secured a change, generally to asphalt.

During 1907, approximately 57 miles of asphalt pavement was laid in Chicago. Last spring the city secured the services of an asphalt expert, employed a chemist and assistants, equipped a laboratory, and is now exercising a close inspection of materials and work. Better results have been obtained, as trusting to long-term guarantees has not in all cases proved satisfactory. A comparison of the cost of maintenance of different classes of pavements upon which the guarantee period has expired is unfavorable to asphalt, as deterioration is rapid when holes begin to appear, and when marked deterioration begins it is necessary to make frequent repairs to prevent the entire destruction of the pavement. During 1907, the average cost of repairs was 25 cts. per sq. yd. per annum, on pavements 9 to 15 years old. The contract price for repairing was $1.49 per sq. yd. It would be well if this matter could be taken up by the American Society for Testing Materials, with a view of adopting standard specifications for asphalt pavements. Exceptionally good results have been obtained with creosoted wood blocks; samples from paving in use under fairly heavy traffic for several years showed a wear of only ⅛ in.

Mr. Moore thought it a mistaken policy to accede to the wishes of a majority of the abutting property owners as to the character and extent of the proposed improvements. In a supplementary report, Mr. Prout (Wheaton) referred to the proposed Wheaton Boulevard, from Chicago to Wheaton (25 miles); then branching to Elgin and Aurora, 55 miles in all. Part of this is already under contract.

A paper by Mr. Linn White (Chicago) described the macadam and bitulithic construction of the boulevards of the South Park Commission, with cost, etc. He also described the results of experiments with tar preparations, oil, etc., for laying dust and making a road surface that will better resist the disintegrating effects of automobile traffic. Particulars of this work have been published in our columns. Mr. J. G. Gabelman (Chicago) presented a paper on "The Binder Course in Asphalt Paving," and called attention to the lack of uniformity in the specifications for this part of the work. About the only point upon which there seems to be no difference of opinion is the clause: "Should the binder appear dull from overheating or lack of cement it will be rejected." Mr. Hittell (Chicago) presented a paper on "Tests of Creosoted Block Paving," which referred to work in Chicago.

The matter of highway improvement was discussed by Mr. A. N. Johnson, State Highway Engineer, who stated that communities are now beginning to recognize the value of the assistance offered by the State Highway Commission, so that the demand for engineering advice is growing. He showed that the work lies in demonstrating the advantages of good construction, and does not interfere with the field of the practising engineer or with the contractor for

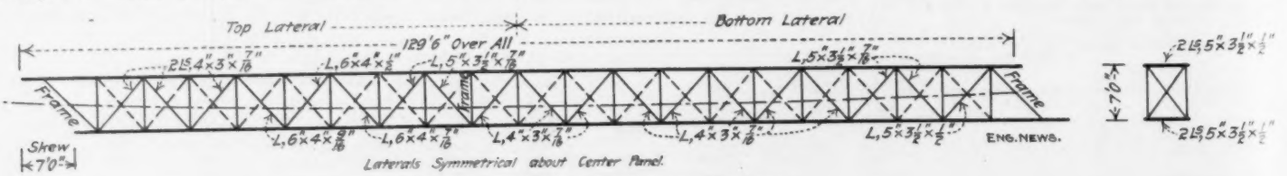


FIG. 2 (b). DETAILS OF LATERALS.

road material. On the contrary, it tends to develop a field for the engineer, the contractor and the material firm.

MECHANICAL ENGINEERING.

Prof. L. P. Breckenridge (Professor of Mechanical Engineering) gave an interesting address on "The Construction of Boiler Furnaces for Smoke Prevention," briefly outlining the theoretical requirements and the practical conditions. As 85% of the power development in this country is by steam boilers it is important to study this matter carefully. A paper on "Modern Power Plant Practice," by Mr. J. C. Thorpe (Assistant Professor of Steam Engineering) related largely to economic principles and conditions, together with operating costs. He showed that the steam turbine and the gas engine have attained commercial success in large units, and that the use of the former has led to important developments in high vacuum for condensing equipment and to marked changes in electrical equipment due to its high relative speed, and also with the adoption of high voltage transmission. He estimated the relative cost of maintenance and operation of different types of plants as follows: reciprocating engines, 100%; steam turbines, 79.64%; reciprocating engines and steam turbines, 75.72%; gas engines, 50.67%; gas engines and steam turbines, 46.32%.

A paper by Mr. C. M. Garland discussed "Developments in Gas Engineering," mainly in regard to gas engines and producers. Mr. J. M. Bryant presented a paper on "Metallic Filament Lamps with Special Reference to Street Lighting," illustrating it by different types of lamps. He showed a comparison as follows:

Lamp Filament.	Candle-power.	Watts.	Watts per c.-p.	Life, hours.	Cost per lamp.
Carbon	16	50	3.10	500	$0.16
Metallized.....	20	50	2.50	700	0.25
Tantalum	25	50	2.00	700 A.C. / 1000 D.C.	0.50
Tungsten	40	50	1.25	1000	1.50

DRAINAGE AND LAND RECLAMATION.

A special session devoted to these subjects was opened with some remarks on "State Land Drainage and Reclamation" by Mr. H. Foster Bain, Director of the Illinois Geological Survey. This was followed by an address from Mr. Isham Randolph (Chicago) on "The Aims and Purposes of the Illinois Internal Improvement Commission." This commission was appointed by the Governor in accordance with an act of the legislature, and its special purpose is to investigate the practicability of a navigable waterway from the Chicago drainage canal to the Mississippi River. In addition to this, the relation of such a waterway to the matters of water power and land drainage will be considered, including the disposition of the excavated material for use in levees and in filling low lands for protection and reclamation. The first report was made in 1907. While the waterways above mentioned is the main consideration, it is proposed to investigate the possibility of navigation and water-power development on certain other streams, while it is proposed to obtain and compile information as to the areas of land capable of reclamation, the present levee systems, and the methods of paying for such work. A bill has also been introduced requiring that commissioners in charge of work done under the state drainage act of 1879 shall make report of such work (its character, estimated quantities and cost, etc.) to the State Geological Survey.

Mr. J. G. Mellulsh (Bloomington) gave a review of the proceedings of the National Drainage Congress held at Baltimore, Md., in November, 1907.

A paper on "The Drainage of Land Protected by Levees" was read by Mr. J. A. Harman (Peoria), describing some of the experiences with levees and pumping plants. The plans generally have a capacity equivalent to ¼-in. of rainfall per hour on the area tributary to the ditches, but this has not been found satisfactory. One great trouble is the parsimony and neglect of the local authorities in regard to the maintenance and operation of pumping plants. The pumps may be operated by compound condensing steam engines or by gas engines with producers.

Two short papers were then read by the Secretary. The first was on "The Improvement of the Upper Mississippi River for Navigation," by Mr. Lewis Boswell, relating to the work now under way to give a permanent 6-ft. channel, with the assistance of storage reservoirs on other rivers. The cost is estimated at $20,000,000, and Congress has appropriated $2,000,000 to be expended in four years. The second paper was by Mr. George A. Ralph, State Drainage Engineer of Minnesota, on "The Reclamation of Minnesota Wet Lands." A paper by Mr. P. C. Knight (Pontiac) on "The Drainage of Agricultural Lands" discussed the use of open ditches and tile subdrains.

STRUCTURAL WORK AND REINFORCED CONCRETE.

Several papers were presented on concrete, in addition to that on the concrete sewers of Decatur, already mentioned. Prof. A. N. Talbot presented a review of the tests of reinforced concrete at the University of Illinois. These have included beams, columns and culvert pipe.

The reinforced-concrete pipes were 48 ins. diameter and over 8 ft. long. They were embedded in sand at the bottom, sides and top, and the load was applied in such a way that it was nearly uniformly distributed over the horizontal projection of the pipe. These tests showed that the pipe is capable of taking large loads. The pipe carried 125,000 to 140,000 lbs. before the structure failed to act as a reinforced-concrete structure. Beyond this point, the pipe seemed to act as an arch under side restraint and carried a much higher load before final failure. In one case the final load amounted to 256,000 lbs. It is evident that the side restraint, or the horizontal force acting against the pipe, must be a large element in the action in the embankment. It is also evident that the proper filling in at the sides of the culvert is a large element in the stability of the structure, and that railways may well expend a considerable sum in properly bedding and filling over the sides and at the top of the culvert.

A paper on "Small Highway Bridges," by Mr. C. Older (Springfield), showed the costliness of the ordinary cheap bridges on country roads. In Illinois nearly $2,000,000 is spent annually on bridge maintenance, and probably half of this goes to the maintenance of bridges less than 50 ft. long. Small wooden bridges are most numerous, and then come steel structures "often of the most primitive and fantastic design." Stone and concrete arches are only occasionally seen. The State Highway Commission has prepared designs for concrete bridges up to 42-ft. span, as well as concrete floors for the longer steel bridges. Up to 18-ft. span, a simple slab is used; above that there are concrete side walls serving as girders and formed in one piece with the floor slab. These girder spans are better adapted to the level areas of Illinois than are concrete arch spans.

Prof. F. O. Dufour presented a paper on "The Economical Efficiency of Reinforced Concrete Rectangular Cross Sections." Mr. R. V. Engstrom, in a paper on "Reinforced Concrete Building Construction," described a case where (owing to lack of space) the materials were stored, handled and mixed in a timber structure carrying overhead bins. At one corner of the building was a timber tower with a derrick boom.

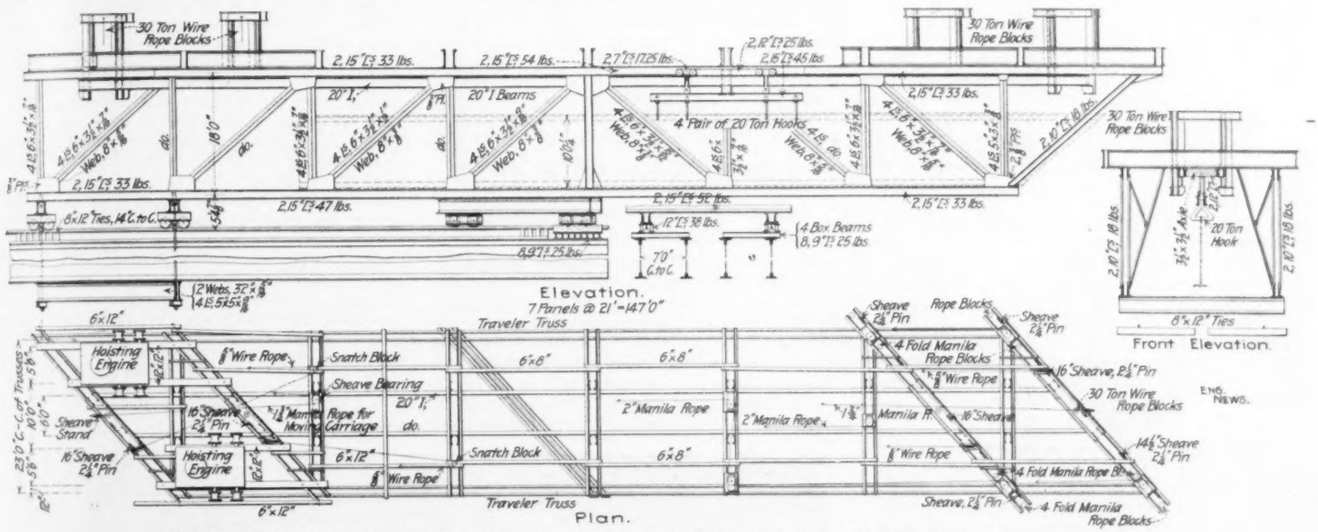


FIG. 3. DETAILS OF TRAVELER USED IN ERECTING THE HEAVY GIRDERS ON THE TOWANDA BRIDGE.

The concrete was conveyed in steel dump cars running on narrow gage tracks over the floors. Prof. N. C. Ricker presented a brief paper, "Notes on Architecture in 1908."

SURVEYING.

The old question of the licensing of surveyors came to light again, and after some attempt to get a committee appointed "with power to act" (thereby committing the society to the views of a few members) a resolution was passed for a committee to be appointed by the President to submit the matter to the Governor and try to persuade him to take it up in his message to the Legislature. One objection was that "the Governor knows no more about surveying than the average citizen, while the legislators know less."

Mr. C. C. Wiley (Champaign) presented a paper on "Recent Improvements in Surveying Instruments." This dealt with the ordinary transit and level, and pointed out the great improvements in the dumpy level, which is now equal (if not superior) to the Wye level. He exhibited a transit built to the designs of Prof. L. S. Smith (University of Wisconsin), and Prof. Smith explained its features, one of the most important being that it is a combined transit and level. This instrument was described in Engineering News in 1906. A paper by Mr. W. H. Herron (Washington, D. C.) discussed "Topographical

Methods and Results in Illinois," and Mr. E. W. McCrary presented a paper on "Topographic Mapping in Bottom Lands." Mr. A. L. Webster (Wheaton) described a concrete monument or stake, designed by him, and used in marking the corners of lots. It is 24 ins. long, 4 ins. square at the top and tapering on two sides to 4 by 5 ins. at the bottom. The surveyor's initials and the year are marked in the top (which has a ¼-in. hole.) The concrete is composed of 1 cement, 2 torpedo sand, and 4 small gravel; for the top, a 1:3 cement and sand mixture is used, so as to give clear, sharp letters. These monuments are made by the Hotchkiss Concrete Stone Co., of Chicago.

RAILWAYS.

A paper by Mr. W. D. Gerber (Chicago) reviewed the standard designs recently adopted by the Chicago, Rock Island & Pacific Ry., for its track, roadway and trestle details. These standards relate to some 14,500 miles of line. Of a different character was a paper by Mr. J. A. Shepardson on "The Construction of the South and Western Railway." This road is being built in the rough mountainous sections of Virginia, Tennessee and North Carolina, and involves some very heavy work. Mr. G. W. Pickels (U. of Ill.) presented a paper on "The Design of Railway Switching Yards," relating largely to methods of operation. Mr. M. L. Enger (U. of Ill.) reviewed "The Relation of Waterways to Drainage Areas," referring to culverts and waterways across railway lines. This led to some discussion on the general subject of run-off and drainage areas, supplementing a former discussion on the papers on drainage, already mentioned.

MISCELLANEOUS.

In a paper on "A Record of Some Paint Tests," Mr. C. H. Nicolet (La Salle) described experiments made to determine the efficiency of paints for steel structures. The tests were made on both clean and rusted surfaces, and in some cases the latter were better preserved than the former. This was a very unexpected result, as one of the requirements for protection of steel surfaces is thorough freedom from rust. It has not been determined what factors contributed to this result. Mr. W. P. Blair (Terre Haute) discussed the vexed subject of "Special Assessments for Public Improvements," and their equitable distribution. A paper by Mr. George L. Sawyer (Seattle, Wash) gave a brief and interesting review of "Engineering in the Northwest," its present and prospective development. He considers that this section of the country offers good inducements to the young engineer who is "prepared to take the bitter with the sweet," but he warned against a sudden inrush of engineers at the present time. Mr. John W. Alvord gave an interesting talk on "Engineering in Mexico," illustrated by a large number of stereopticon views from photographs taken during his visit to Mexico last year with the American Society of Civil Engineers.

OFFICERS AND PLACE OF MEETING.

The report of the Secretary and Treasurer showed a membership of over 200 and a bank balance of $730, with all bills paid, and $148 annual dues in arrears. The officers for the year 1908 are as follows: President, Charles B. Burdick, Chicago; Vice-President, F. W. Honens, Sterling; Secretary and Treasurer, E. E. R. Tratman, Chicago. The next meeting will be held at Chicago in January, 1909.

A CORRUGATED STEEL CENTERING FOR CONCRETE WORK.

A new corrugated steel forming for concrete floor, wall and sewer construction, which has been invented by Mr. Keith O. Guthrie, Assoc. M. Am. Soc. C. E., seems to have some features that merit description. This new form, which is called "Duralite," is made of two light gage steel plates fastened to a separating layer of specially corrugated steel sheeting. The depth between the outside sheets is varied from 1½ to 3 ins., according to the requirements of the work; the gage of the sheets running from No. 24 to No. 16. Under test flat sections weighing about 4 lbs. per sq. ft. of surface develop about twice the resistance of 2-in. yellow pine planking.

When used as wall forms the flat panels, made up in suitable sizes, are much stronger than the usual plank and therefore permit of the studding being placed at much greater intervals than in regular timbering forms. In using the sheeting for curved forms or centers for small arches, culverts and sewers the inside sheet of steel is replaced by narrow strips or bands, spaced about 2 ft. c to c., and the bolt holes on the inside face are so spaced that the whole trussed plate is drawn into any curve desired.

This system is especially adaptable to sewer molds on account of the absence of any inside bracing and the ease with which it may be moved along for continuous work.

Fig. 1 shows the use of "Duralite" in a 13½ ft. sewer. In this case the section AA is first suspended from a cross brace in the trench (shown dotted) or supported by blocking from the bottom and the concrete laid up to A, and then the sections AB with their connecting 6-in. strut are placed. The concrete is then laid to B and the portion B A B emplaced, being hooked at B to the lower section. Now the section A A may be unbolted and lifted out and slid, along the I-beam hanging from the cross strut, to its new position in the next length of the sewer, the upper form meanwhile being held by the pressure of A B against the hardened concrete. When the upper ring has sufficiently hardened, the bolt in the lower plate at the crown of the arch may be drawn and the upper section wedged out of place, as shown by the dotted lines on the figure, and rolled along and placed under the succeeding section A B, which has already been put in place. It will be seen that two lengths of sections A B and one length of the other sections are required for continuous work. The number of sections necessary is dependent upon the amount of concrete that can be laid in a day and the extent of the forward excavation.

There are many variations in methods of using the centering, but this will illustrate the general principle involved. The half-tone reproduced in Fig. 2, shows another method of using the form which was adopted in a Brooklyn, N. Y., sewer.

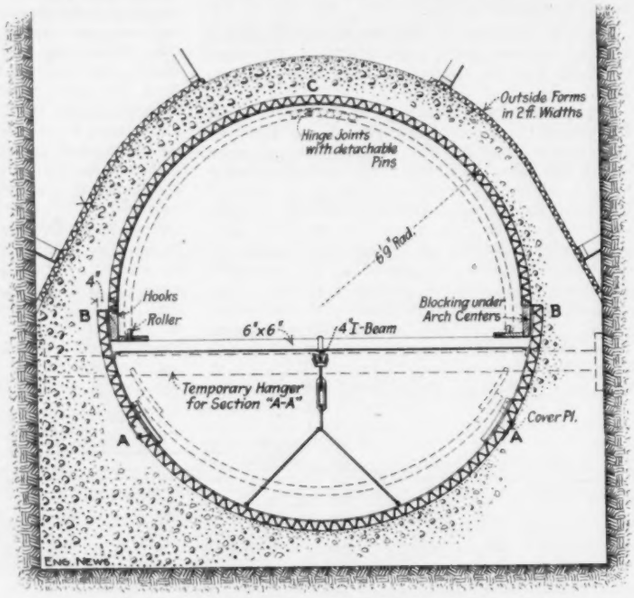


FIG. 1. USE OF CORRUGATED STEEL CENTERING IN SEWER CONSTRUCTION.

A 3-TON GASOLINE LOCOMOTIVE for use in quarries, mines, industrial plants, etc., has recently been built, in which a countershaft under one end carries crank arms from which connecting rods are led to the first pair of driving wheels. The four driving wheels are coupled. A two-cycle reversible engine is used, geared to the countershaft. The first of these locomotives is in use in a coal mine, and can haul 60 tons at 8 mi. p. hr. It was built by the Termant & Monahan Co., of Oshkosh, Wis.

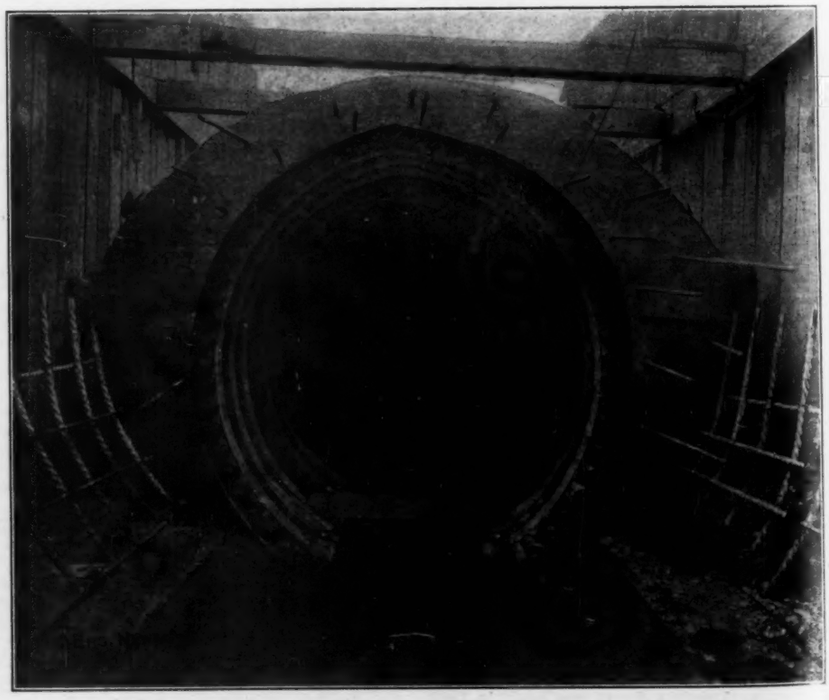


FIG. 2. "DURALITE" CENTERING IN A BROOKLYN SEWER.
Section Drawn in and Being Moved Forward.

STATEMENT OF COL. GEO. W. GOETHALS, CHAIRMAN OF THE ISTHMIAN CANAL COMMISSION, BEFORE THE SENATE COMMITTEE ON INTEROCEANIC CANALS.

The Senate Committee on Interoceanic Canals on Jan. 16, 17 and 18, had before it for examination, on the Panama Canal work, Secretary-of-War Taft and Col. Goethals. We have extracted from the testimony of the latter some of the matter of most interest to our readers and print it as follows:

Congress adopted the lock type of canal in June, 1906. Prior to this time excavations for the canal route were confined to the Culebra Cut, along the line that the French were working.

Mr. Stevens had a thoroughly organized force at work in the Culebra Cut, and had succeeded in getting an output of over 800,000 cu. yds. during the month of March, the last month that he was in charge. He had just installed the fourth shovel at the Gatun lock site. When we took hold of the work on April 1, 1907, we made a rough estimate of the quantity of work still to be done, and concluded that the limiting features in the project as to time for completion were at the Gatun dams and locks, and the dams and locks on the Pacific side. The Chagres River Division, extending practically from Bas Obispo to Bohio, while not containing a very large amount of material to be removed, was crossed by the Chagres River 23 times; and as the chances were that it would be flooded out at every rise of the river as the work progressed, the necessity of beginning work on this division was apparent. So that the work was enlarged with a view of completing all parts of the canal practically at the same time; and a force was placed at Gatun for excavating the spillway—that is to take care of the waters of the Chagres, the Trinidad, and the Gatuncilla during the construction of the dam.

Considerable criticism has been made of the location of the Gatun Locks because of the character of the foundations. Borings were made, and made hurriedly, for the use of the consulting board. Not satisfied with that, test-pits were sunk to the level of the lock foundations; and a Board of Consulting Engineers, after examination of these test-pits, pronounced the rock suitable for the foundations of the locks. We found that in the Culebra Cut the geological formation changes very frequently. We heard various questions as to the character of the material below the lock foundations or the level of the foundations for the lock walls; so that we began a systematic set of borings covering the entire area to be occupied by the locks, extending them down to a depth of 25 ft. below the level of the lock foundations. To satisfy ourselves that the material on which the locks are to be built has sufficient strength to withstand the pressures brought to bear upon it, and that below the rock layer on which the locks are to rest no bad material will be found, in some instances we have carried these borings down to 70 ft. below the lock foundation. The locks are to rest on a comparatively hard argillaceous sandstone. Below this argillaceous sandstone is found a layer of conglomerate, which is cemented, thus forming rock, and which gives a good foundation; it is not water-bearing. Below this conglomerate, extending from about the center part of the upper lock, and entirely disappearing at the middle of the lower lock, is a softer sandstone in which some water is found. Below the softer sandstone, which is about 8 or 10 ft. in depth, as I recall it, we again strike the hard argillaceous sandstone, which extends down as far as we have gone with our diamond drills.

At the Gatun Dam site the excavation of the spillway is progressing. Diamond-drill borings have been made on the site of the spillway, and there the hard argillaceous sandstone is found. The superimposed material is a stiff, hard, red clay, absolutely impervious to water.

Prior to the slough-off of the Wachusett Dam we had concluded to change the cross section of the Gatun Dam so as to avoid any possibility of a sloughing-off in our Gatun Dam. Up to Reference 30, above mean tide, which is 55 ft. below the normal level of the water in the lake, there will be a rock pile at least 50 ft. wide, the material being trap rock secured from the Cut at Bas Obispo. This bank of rock will be widened if we have any surplus material to deposit. That rock will be placed on the upstream toe of the dam. The downstream toe of the dam will be constructed in the same way, of rock and earth taken from the excavation for the Gatun locks, up to Reference 30. On the upstream side of the dam the slope is to be made 1 on 5 instead of 1 on 3, and is to extend to the elevation of 105 ft. above mean tide. From there up to 135, which is the reference of the crest of the dam, the slope is to be 1 on 3. On the downstream side the slope is 1 on 3 to about Reference 85; and from there down the slope is 1 on 25 until it strikes the rock pile, the width of the dam at the bottom being left practically that advocated by the Consulting Board—half a mile. The accident to the Wachusett dam has indicated that the change was a wise one and it was made after consultation with the Consulting Board.

CHANGE IN LOCATION OF THE PACIFIC LOCKS.

On the Pacific side the locks extended, under the original project, into the Pacific. The lower lock was entirely in the Pacific, and a portion of the upper lock. The lake there was formed by a dam extending from the locks to San Juan Hill, on the west, and also by a dam extending from Sosa Hill to Corozal. Throughout that bottom, the bottom of the Rio Grande, there is nothing but soft silt, and very little sand. The Consulting Board proposed to dump the material from the Culebra Cut on this soft bottom, and to pump between the dumps on either toe of the dam the material excavated by dredging in the lake itself, and the channel outside the dams. We began this work by building trestles on the up and down stream toes of the dam, from which material from the Culebra dump was placed as soon as the trestles were long enough to take the trains; and our troubles began. Instead of finding stiff clay under the 10 ft. of silt, as was supposed existed, we found a blue, unctuous clay without any grit or resisting material whatever; and the stuff that was dumped from the trestles slipped out side wise instead of going to the bottom and finding rock, as the board anticipated would be the case. After a thorough examination made by wash borings, and procuring drive samples, we concluded that the only satisfactory way in which that dam could be built and be secure against slipping was by excavation of that soft material, and going to rock. To trust to the superimposed mass finding rock would be expensive in time and money, and would leave doubt as to the stability of the structure. There was an objection to the locks extending into the Pacific from a military standpoint; so that a systematic investigation was made of the line from La Boca Dam to Miraflores, where the French had originally projected a lock, and where, from their records, we knew we could get excellent rock for lock foundations. The majority of the Consulting Board had also advocated this as the site for the tidal lock that the sea-level canal project required at the Pacific end. We found a location for the lock between Aguadulce and Miraflores in which we have excellent rock for the locks, comparing very favorably with the rock we have at Gatun; the dams are low and short, and rest directly on rock. A comparison of cost shows that the moving of the locks from the Pacific or at La Boca back to the Miraflores site will result in a saving of $8,000,000, approximately, in money, and a saving in time in the construction of the dams.

The Culebra Division organization remains practically as organized by Mr. Stevens. The number of steam shovels in this division was reduced in May, no additional ones having at that time been ordered, as the work on the Panama Railroad at Gatun as well as at La Boca was of such importance as to necessitate the removing of some of the steam shovels at Culebra. As stated by the Secretary yesterday, it is the intention to cut down the excavation at Culebra so as to keep the work in that Division going at the same rate as the work on the other parts of the line.

ESTIMATED EXPENDITURES FOR 1908-1909.

In submitting the estimates for the next fiscal year, after revising them since the Appropriations Committee of the House visited the Isthmus, we have asked for the Department of Construction and Engineering (which would include the Washington office, and all incidental expenses connected with the Washington end and the Commission on the Isthmus), $28,365,333; for sanitation, the sum of $2,172,420; for expenses of the Zone government, $682,070; for continuing the improvement of the Panama Railroad, $1,183,940, making a total of $32,403,763.60.

So far as the Lock and Dam Department is concerned, we are somewhat at sea in determining the number and pay of employees. We know that we have to remove a certain quantity of material in order to get the foundations; and we expect to reach the foundations and have them prepared in time to lay concrete the 1st of January, 1909. We expect to have the machinery in place for laying the concrete in November of 1908. We expect to lay not less than 2,000 yds. of concrete a day. Based on the assumption, then, that the excavation will be completed and that we will have to lay 2,000 yds. of concrete per day for six months, we have estimated on that basis (at the rate of $8 a yard for concrete) that the total required for the Lock and Dam Division will be $6,210,500. That includes a part of the plant for the Miraflores Locks.

In the Department of Sanitation the estimates, based on the current work, amounted to something like $3,000,000. That included materials, supplies, and labor for the work of sanitation, and also for the hospitals and the care of the sick along the line. All of the estimates had to be reduced. They summed up, when they reached me from the various departments, in the neighborhood of $40,000,000. I concluded that the amount for sanitation could be reduced; and I therefore requested Colonel Gorgas to reduce his estimate. He did so, and cut them down to the amount that I have specified for sanitation.

It is pretty hard for us, as the Secretary of War stated, to deny the doctors; but conditions on the Isthmus are such that I think if we had a lump sum annually of $2,000,000 for sanitation, that ought to supply all their wants, with the understanding that should an emergency arise requiring a greater expenditure we will make the expenditure, and ask Congress to authorize it afterwards. Should yellow fever break out, I fear there would be a stampede, which would delay the work very materially. That I judge from the fact of the feeling that existed on the Isthmus in July last, when a case of yellow fever was brought into the Zone from one of the ships on the Pacific side. The period of infection, however, had passed; and while there was no danger, the feeling among the workmen, as I heard it expressed, gave some indication of what the result would be if a case of yellow fever did actually break out on the Zone.

Our death rate now is very low, comparatively speaking; and I do not think that health conditions there are any worse than they are in some parts of this country, if the men will take proper care of themselves.

WAGES AND SALARIES.

So far as the wages are concerned, I do not think the higher officials are paid too much because of their responsibilities. So far as the skilled labor is concerned, we are paying from 50 to 70 per cent. in excess of the wages for similar classes of work in the United States. In addition to that, we are providing the men with quarters, lights, fuel, and water free; for the monthly employees, six weeks' leave per year with pay; fifteen days' sick leave in six months for all employees of the skilled class, cumulative, not to exceed thirty days in any one year; free medical attendance and medicines while sick; a roundtrip pass on the Panama Railroad once a month, for which the Commission pays; and to my mind the scale of wages is high, considering all the privileges that are given. They also have police protection, roads, streets in their villages, and school advantages. But we have gotten to that state where it is difficult to cut down; and I told the House Appropriations Committee that if they desire a change it could be done by legislation, and I asked that they take part of the onus, and not throw it all on the Commission, by stipulating that the rates of pay shall be a certain percentage over and above what similar labor is paid in the United States.

The common labor consists of whites, Spaniards and Italians, and Greeks, and also some sheiks from India. They are paid at the rate of 32 and 40 cents silver per hour. I do not think this is too high. The colored laborers are paid 13½ cents per hour if the Government subsists them, and 20 to 32 cents an hour if they subsist themselves. The 32 cents an hour is paid to subforemen in charge of small gangs.

It costs the Commission 30 cents gold per day to feed the West Indian or negro labor. It costs the white labor 40 cents gold a day for three meals at the Government messes. They are not obliged to take their meals there, but if they do they pay for them. The Commission found it necessary to feed the colored labor in order to increase its vitality and efficiency, and it has worked very satisfactorily. The white labor takes care of itself better and feeds itself on nourishing food.

THE CONTRACT PLAN VS. HIRED LABOR.

In the question of contract versus hired labor, I gave the matter considerable thought and discussed it very freely with other members of the Commission, and concluded that as matters now stand it is much more economical for the Government to prosecute the work in the manner that it is now being done than by contract. The advantage of contracting, it is claimed, is that it ordinarily results in a reduction in the price. That I have never believed, and do not now believe. I have never known of a piece of Government work that has been done by contract that has been done cheaper than the Government could do it, if you take into consideration the manner in which it was done. If such work can be done cheaper, it is due to the fact that you are renting from the contractor a certain plant which he has. But if the contractor is forced to go into the market and buy the plant, and at the conclusion of the job has no further use for the plant, the work is going to cost just as much by contract as it does by hired labor. And that is equally applicable with the Government as with a private individual or corporation.

The conditions on the canal are such as to absolutely prevent the drawing up of any specifications that would give an accurate statement of the work that is being done. We do not know for any distance the character of the material that is to be encountered, except where careful borings and examinations have been made. I do not believe in any form of contract in which all the chances are to be taken by the Government, and the contractor merely acts as a labor agent. That was the form of contract that was under advertisement or under discussion here a year ago. I think a contract should be drawn so that the Government could get some idea of the cost of the work and the time required for its completion. I do not think any form of contract could be drawn for the canal work that would give these.

It has been claimed that the contractor ordinarily has an organization which he can put at work, and the Government has not. There is no contractor or combination of contractors in the country that has an organization that is better, if as good, as that which we have

in the Culebra Division to-day. There is no contractor or combination of contractors that has had the experience in laying heavy masses of concrete, or in the construction of locks, that can be found among the Government's agents. There is no combination of contractors that has a plant sufficient to do that work. The contractor will have to furnish it all and ship it there. It must be practically counted as a total loss to him on the completion of the work. The Government has a plant, 80% of which is on the ground to-day and in operation. The Panama Railroad must, during the construction of the canal, be utilized for commercial purposes; and it would be absurd to turn the railroad over to a firm of contractors and ask them to run the commercial end of it as well, and expect them to do it as cheaply as the Government can do it.

So far as the dredging is concerned, the Government has done dredging cheaper than any contractor; and that is indicated by the fact that Congress has passed a law which prohibits the construction of dredges by the Government for doing Government work in certain sections of the country. The Government attempted for one year the construction of its fortification works by contract, involving large masses of concrete. At the expiration of the year, or prior to the expiration of the year, the Government was in charge of most of those plants, and laying the concrete itself. The poorest fortifications we have to-day on the coast, either the Atlantic or the Pacific, are those which were built under contract, and at a greater cost to the Government than those built by the Government itself.

The West Indian laborers, particularly, were treated by the French contractors in such a manner that I very much question if a contractor could secure the necessary labor. We are now in a condition to secure all the labor that we please from Italy. The understanding with the Italian consul however, is that should the Government turn the work over to a contractor, Italy will again prohibit any of its labor going to the Zone.

As to the cost of the labor on the Isthmus, I question if a contractor could secure it any cheaper. So far as the higher payment to labor is concerned, the Government has already established a rate of pay which a contractor would have to maintain, so far as the skilled labor is concerned; and we are paying now as low a rate for common labor as any contractor could procure it for.

Another advantage that has been claimed for a contract is that the time of the completion of the canal would be definitely fixed. That I dispute. Relatively few contracts with the Government are ever completed on time. In a number of the contracts that we make for materials and supplies, the contractor has the right to fix his own time for delivery; and in ninety-nine cases out of every hundred the contractor fails in delivery at the time specified. An examination of the records of the War Department will show conclusively that as a rule contractors fail to complete their work on time, and most of the contracts are extended.

COMPLETION OF THE PLANT FOR THE WORK.

I stated that about 80% of the equipment has been purchased. We have practically all the steam shovels and cars that we expect will be required on the work. As the work in the Culebra Division progresses, and the cut narrows, the number of shovels will be reduced, and they will be utilized in other parts of the work. We have under contract all the dredges that we expect will be needed for the work. Those required for the stretch of canal between Gatun and the Chagres River will be, probably, old French dredges which we have found in the jungle, and which will be subsequently fitted up as needed. The large plant still required, and for which estimates are submitted either in the deficiency items or in the estimates for the next fiscal year, is for the construction and operating plants of the locks. That we expect to have on hand, complete, in the next fiscal year.

Replies to Questions by the Committee.

COST OF LIVING IN THE ZONE.

Senator Brandegee. If you think rates paid for labor are too high, is it possible to get the labor for less?

Colonel Goethals. I do not think it is, now. The difficulty would be that we would upset the conditions on the Isthmus to such an extent that we could not stand for it.

Senator Flint. As a matter of fact, Colonel, the laborers there are unable to save very much, even at the high wages, are they not?

Colonel Goethals. I think they save a good deal.

Senator Flint. Everything is very high there, is it not?

Colonel Goethals. No. The commissary prices are relatively low. That is where the difficulty comes in. We are paying less for meats down on the Isthmus than I am paying right here in Washington to-day. Some of our supplies are higher; but as a rule it is confined to anything you buy in Panama. Servants wages are high; but the cost of living so far as the necessaries are concerned is less; and everybody who goes down there with the idea of staying goes down with the idea of saving. That is what keeps them down there.

CUTTING OFF SEEPAGE UNDER GATUN DAM.

Senator Taliaferro. Will the Gatun dam rest on a foundation of material that is absolutely impervious to water?

Colonel Goethals. Yes, sir; we expect to cut into that material, forming a wedge-shaped cut, in which will be compacted a puddled core of clay, gravel and sand. That will form the bond between the natural surface of the ground and the dam itself. Where it crosses the Chagres River, the diversion channel, and the old French canal, all the soft material will be excavated down to impervious material, sand and gravel; and to add additional security sheet-piling will be driven down from 50 to 75 ft. That we do not think is necessary. In fact, there is a good deal about the dam that we do not think is necessary, but which we are doing simply to give confidence; because there has been so much said about the liability to failure, and there is no other way in which we can convince the people that it is secure except to take every possible safeguard.

THE CEMENT SUPPLY.

Senator Taliaferro. Have you ever considered the question of making your cement on the Isthmus?

Colonel Goethals. We have done so, and we may be forced to do it. We will advertise for the cement that we require this month; and if the bids are exorbitant, that is what we purpose doing. We do not want to do it if we can help it, as it adds to our troubles.

Senator Taliaferro. How about the cost?

Colonel Goethals. According to the geologist's report, we can make cement at a reasonable cost. I understand it is about $1.34 per bbl. But the manufacturers in this country are very anxious to have a chance to furnish the cement, and we would like to have them do it if they will do it at a reasonable cost.

PAY OF SKILLED WORKMEN.

Senator Taliaferro. Who originally fixed the scale of wages that you found in existence when you went in, Colonel?

Colonel Goethals. I presume Mr. Wallace and then Mr. Stevens; the latter practically organized that work. As regards the steam-shovel men, there have been many accounts as to the reason for their demand for $300 per month. It was stated that Mr. Wallace promised them $300. Whether he did or not, I do not know. But they demanded it last spring, and carried the matter up to the President. They were getting originally $180 a month; and Mr. Wallace promised them a bonus of $30 a month provided they exceeded the output by a certain number of yards per month. It was impossible to carry out that idea of a bonus, because the transportation service was such that every shovel could not be supplied with trains at the same rate. So Mr. Stevens raised their pay to $210, giving them all the bonus. They are all working at about the same rate when the car service is the same for all the shovels. They then made the demand for this $300. Their increase has been a longevity increase since we have been there—5% for one year if the service is continuous, and 3% in addition at the expiration of the second year if there is continuous service. That is all the increase the steam-shovel men have gotten.

The locomotive engineers in the Construction Department made a demand for higher pay, because in the States they are paid higher than the steam-shovel men. Their pay was $180. They were placed on a level with the steam-shovel men—$210 a month. That increase took place since April 1. The same way with the conductors; they were raised from $150 to $190 at the same time.

The machinists' pay, and the pay of all mechanical trades, has been increased by reason of this longevity increase, which is given at the rate of 5% at the expiration of one year's continuous service and 3% for each additional year's service, provided the service is continuous and satisfactory. Those are the increases that have been made.

ESTIMATE OF THE TOTAL COST OF THE CANAL AND TIME REQUIRED FOR COMPLETION.

Senator Taliaferro. How much of the railroad line comes within the canal line?

Colonel Goethals. Practically all of it, except about a couple of miles on the Atlantic side, and then you come into Corozal; and with the new line, under this new location of locks, all but about 5 or 6 miles.

Senator Taliaferro. What is it going to cost to build the new railway line, Colonel?

Colonel Goethals. The Consulting Board of Engineers estimated its cost at $3,700,000, without knowing anything about where the line was to be. We have made no estimates, since we took hold, of the cost of the relocation.

Senator Taliaferro. Do you think that estimate about corresponds with the facts?

Colonel Goethals. I think it very much too low. We are already estimating, for that part around Gatun, over $1,000,000.

Senator Taliaferro. Have you made any figures or estimates at all as to the ultimate cost of the canal?

Colonel Goethals. A rough guess was made in April, when we figured out the amount of excavation to be done; that is all. A guess made then was that we could build it within the $250,000,000. As the amount authorized by Congress will be expended in the next fiscal year, we shall have to prepare an accurate estimate. We expect to be in a position to do that the next year, because we will know where all the material for the Gatun Dam is to come from; and we will also know the cost of concrete. That is still an uncertain factor, because of the ignorance of the cost of cement.

Senator Taliaferro. And your recent guess is what?

Colonel Goethals. The guess, made in April, was $250,000,000 total cost, exclusive of the purchase money.

Senator Taliaferro. Which would add $50,000,000 more?

Colonel Goethals. Yes, sir.

Senator Taliaferro. I suppose you would not care to venture on an estimate of the time until you can see how your concrete work will progress in the construction of the canal?

Colonel Goethals. No; we have never doubted that we will finish the canal in the time estimated by the majority board. They estimated that it would take eight years and a half. The plan was adopted and work begun in June of 1906. We have never estimated less than eight years and a half from that date. We still adhere to that date. Some of us hope to finish it in a less time; but we are not making any estimate as to when. The difficulties that we are liable to encounter are unknown and uncertain. We have had two or three bad slides in the Culebra Division that gave us a little concern. We have gotten through those satisfactorily; but we do not know what is going to happen at any place along the line at any moment. There is where the difficulty comes in.

Senator Taliaferro. These slides are the result of the heavy rainfall you have during the wet season?

Colonel Goethals. Yes sir. We had the Cucuracha slide, which cut off our tracks through the cut at the south end. About 500,000 yds. of material started in motion. For a time it moved at the rate of about a foot an hour. For some time we worked on that slide night and day, Sundays and holidays. That increased the cost of our work in October and November materially. We have had two slides on either side of Gold Hill which threatened to close in on the shovels, and we have had to work there night and day. We had a slide just immediately below Culebra Station. In work of that kind it is the unexpected that always happens, and we do not care to estimate on the time of completion too early.

Senator Culberson. Speaking in general terms, I think it was estimated that this canal at Panama, including the fifty millions, would cost $189,000,000. I understand now, from the answer of Colonel Goethals to Senator Taliaferro, that the cost will be $300,000,000. I would be glad, Colonel, if you would state briefly and definitely where the additional cost over the original estimates will come in.

Colonel Goethals. The estimate for the locks of the Consulting Board was something in the vicinity of $36,000,000. We are estimating that the locks will cost $60,000,000. Their estimate for the unit price for excavation is less than the unit price that we can get the dirt out for at this time. The quantity of excavation that they estimated was 95,000,000 yards, whereas on April 1, 1907, there still remained to be removed 114,000,000 yards. Those are the principal items that go to make up that difference.

Senator Flint. The locks are made larger, too?

Colonel Goethals. The locks are made larger; but that increase of only 10% in the cost would hardly account for that difference of $24,000,000.

In the unit price, I made that distinction for the reason that we are gradually reducing the unit price of excavation. Whether we will ever be able to get it down to that of the board, I doubt.

There is another thing to be considered in connection with those estimates. When the Consulting Board went there, there had been no detailed surveys made of the route. It was all jungle; and they spent six or seven days on the Isthmus. Our estimates are based upon detailed surveys which have been made of the entire route, and allowing, too, for difficulties that the Consulting Board had no idea we were going to have to contend with.

I do not believe that the Consulting Board, in preparing their estimates, had any idea of housing the employees as comfortably as they are housed, which will add considerably to the cost of administration and to the total cost of the work.

DIFFICULTIES IN THE WORK.

Senator Culberson. Colonel, I understand generally from the reports that have been made, that as an engineer officer you do not believe there is any insurmountable difficulty in the construction of the canal?

Colonel Goethals. None whatever; we are all convinced that we can build that canal.

Senator Culberson. Colonel, will you kindly indicate the principal engineering difficulties in the way of the construction of the canal? I would not care to have you make a lengthy statement of them.

Colonel Goethals. I do not know that I could answer that question, because we do not anticipate any difficul-

ties in any part of the work. The dam is going to take longer to build than any other part of the work. There is no doubt about that. That will fix the limit of time. We do not anticipate any difficulty in the construction of the locks. Two of us have been engaged in lock construction from five to nine years. We have built locks before. We have built locks on foundations where water has appeared; and I understand there is a good deal of settlement made in the press because water was found in one of those pits. We do not anticipate any difficulties from that. The truth of the matter is that we anticipate more difficulty in the Cut than we do in any other part of the work, because we have had more difficulty there than we have had at any other part of the work.

Senator Culberson. Is that due to the slides?

Colonel Goethals. To the slides; yes, sir.

Senator Taliaferro. What is the capacity of that lock, Colonel?

Colonel Goethals. It is a thousand feet long and 110 feet wide; the thousand-foot length of chamber is in the clear; from hollow quoin to hollow quoin the length is about 1,065 feet. It will be increased somewhat now; but it is a thousand feet plus the width of the lock gate.

Senator Taliaferro. What is the lift?

Colonel Goethals. The lift averages about 30 feet. On the Gatun side we have lowered the miter sill of the top lock 3 feet so as to allow the drawing down of the upper pool 3 feet. In the lower locks there is a 30-foot lift from Pedro Miguel down to the 55-foot level formed by the dams and locks at Miraflores; and then the 55 feet carries them down to mean tide on the Pacific side. There are two locks. The tide is about 18 feet at Panama.

DAMAGES FOR LAND SUBMERGED BY LAKE GATUN.

Senator Ankeny. In regard to this submerged land, have you considered pretty well what damage your dam will do there?

Colonel Goethals. Yes, sir; we have made surveys of the lake that will be formed when the Gatun Dam is finished.

Senator Ankeny. It is going to be quite a sum, is it not?

Colonel Goethals. One hundred and sixty-four square miles is the surface area of the lake.

Senator Ankeny. As I understand it, when that dam is completed much of this land will be submerged?

Colonel Goethals. Yes, sir; but as far as the Gatun Lake is concerned, the Government owns a considerable part of that land, and Mr. Rogers is making negotiations by which there will be transferred to these parties certain sections bordering the lake in exchange for the land that they now own, without money consideration, as I understand it.

EFFECT OF WINDS ON SHIPS IN LOCKS.

Senator Ankeny. What would be the effect of high winds on ships in your locks?

Colonel Goethals. We do not anticipate any trouble there. The winds normally blow toward the dam and in the lake away from the dam; and there will not be injurious wave action in the lock, on account of the comparatively short length of the lock (only 1,000 feet). I do not anticipate any trouble in making lockages on account of the winds.

Senator Ankeny. Not even with heavy battle ships?

Colonel Goethals. No, sir. The winds are going upstream, practically, considering the locks in flights.

Senator Ankeny. That is, you mean the prevailing winds are from the west to the east?

Colonel Goethals. The prevailing winds are practically from the north to the south. The canal is north and south rather than east and west.

Senator Ankeny. At that point, yes.

Colonel Goethals. Yes, sir; and the winds would follow the ship up the locks, and not down. If the winds were from the other direction there might be some difficulty, but when they enter the lock it is empty, and when the lock is full there is no danger to the gates from the wind.

ORGANIZATION FOR LOCK CONSTRUCTION.

The Chairman. The lock structure is to be made of concrete?

Colonel Goethals. Yes, sir.

The Chairman. What character of workmen must be employed to put in the lock structures and the machinery, and to put the conduits and pipes in place?

Colonel Goethals. A good foreman of concrete, with common labor, can superintend the construction of the locks after the concrete is mixed. It will require machinists to operate the overhead cableways that carry the material from the barges at Gatun to the stock pile, and then from the stock pile to the concrete mixers, and from the concrete mixers to the lock walls. For forming we expect to use steel. In that case it will require common labor with suitable machinery to handle the forms. The amount of additional labor due to the concrete will be relatively small, and outside of looking after the machinery, there will be very little skilled labor.

The Chairman. You stated that you hoped to work on the construction of the locks, or the lock structures, sixteen or twenty-four hours a day.

Colonel Goethals. Yes, sir.

The Chairman. Have you as yet attempted to work men during the night time?

Colonel Goethals. No, sir; we have not found it to our advantage to do so in the excavation work. The excavation costs us a good deal in the way of labor. Steam shovel wages are high and transportation wages are high. We are providing the men with quarters according to their pay, and to work sixteen hours or twenty-four hours would necessitate a very material increase in cost. Under the law we are able to work common labor nine and a half hours—alien labor—and the foremen who are supervising alien labor are required to work the same number of hours. So that by putting two gangs of laborers at the Gatun Locks, or at the other locks, either, it would not increase our expenses as much proportionately as it would in the excavation department, because the amount of skilled labor is relatively small and we could get nineteen hours' work a day out of two gangs. In the other case, under the eight-hour law, we get but sixteen.

EXPERIENCES IN THE PRACTICAL OPERATIONS OF A MECHANICAL FILTER PLANT.*

By C. H. COBB.†

The filter plant at Kankakee, Ill., was put in operation about six years ago. It consisted of a settling basin, 50 × 50 ft., and 16 ft. deep, arranged in duplicate to facilitate cleaning; six filter beds, 12 × 16 × 5 ft., with 3 ft. of sand, with a maximum filtering capacity of 500,000 gals. each; and a clear water basin with about 250,000 gals. storage capacity. At that time we were pumping about 1,500,000 gals. daily. The system of piping in each bed consisted of a separate manifold for the water and air, so that in washing the beds we use the water and air at the same time, thereby, I believe, washing the filter beds with less clear water than where the water and air are used separately.

My instructions from the filter manufacturers (when they turned over the plant to the local company) were to put in a large amount of alum when the water was very turbid, and less when it cleared. I followed the above instructions for about three years. The results were fair when the turbidity was about average or at its minimum, but not always so when the turbidity was at its maximum.

During February, 1904, we had a heavy rain for about two days, taking off about a foot of snow with it; consequently the water was very turbid. We commenced dumping in the alum and used about 3,000 lbs. in one day without clearing the water properly. After the first day it occurred to me that the water might not be sufficiently alkaline to coagulate the alum, so I made a determination for alkalinity and found only 20 parts per 1,000,000. As this amount would only neutralize about 2 grains of alum per gallon, and we were using about 14 grains per gallon, we were wasting 12 grains. The filter manufacturers had made no provision for this state of affairs, having provided no means for introducing either lime or soda ash. I purchased some soda ash and arranged a way to introduce it in the water.

I commenced my improvements by first making some radical changes, as follows: Each half of my settling basin had four baffle plates arranged along the walls, equidistant from each other and staggered, making about 150 ft. of flow in 50 ft. of actual distance. The flow of the water was so fast that eddies were made on both sides of the baffles where they were fastened to the walls of the settling basin. The water was kept in a state of constant agitation, which kept a large amount of matter suspended instead of letting it settle to the bottom by its own weight. I took out all the baffle plates of one-half of the basin. Where the water was introduced, I partitioned off a box or still by means of a fence, the boards running from the bottom to the top of the basin with a total opening between the boards of ten times the area of the 20-in. opening into this enclosure. At the other end of the basin I constructed a solid weir, allowing a flow of about 6 ins. over the top of the weir. This arrangement had the effect of doing away with all currents and eddies, and the flow of the water was not perceptible to the eye. To test the difference in the two methods, I took the turbidity at the point where both basins flowed upon the filter beds, and found the turbidity in the newly arranged basin about 30% lower than in the old basin with the baffles. I then changed the other half in the same way.

On a suggestion from Dr. Edward Bartow, of the State Water Survey, I took up the question of the most efficient coagulant, and tested the use of sulphate of iron and lime water (a saturated solution). By my first method of making lime water there was a large amount of sludge collecting on the bottom of the tank. This had to be cleaned out every two days, with the result of getting more lime into my water at one time than was needed. I concluded to use milk of lime instead. Accordingly, I put in the bottom of my lime tank, which is 9 × 9 ft., a manifold piping system covering the entire bottom. The outlets were 50 of Robert Filter Co.'s sand strainer heads, but instead of having them looking up as they would in a filter bed, I inverted them, so that the clear water coming from them under pressure, every two hours, would agitate all the lime on the bottom of the tank. This method would produce milk of lime of very nearly the same consistency. The milk of lime was discharged by a floating pipe, the opening being about 6 ins. beneath the surface of the solution. With my limited settling basin there was not time enough to get a satisfactory flock and settling with sulphate of iron when the water was at or near the freezing point with very high turbidity. The sulphate of iron worked well with high turbidity and warm water. I then tried alum with milk of lime, and found that where the water would enter the settling basin at a turbidity of from 300 to 400, it would enter the filter beds with a turbidity of from 60 to 80. This gives plenty of flock to make a good filtering mat. Where I formerly used, at times of high turbidity, from 1,500 to 2,000 lbs. of alum per 24 hours, with the lime I could get perfect results with from 500 to 600 lbs. I use alum and lime when the water is at the maximum turbidity and cold, and iron and lime at all other times. The sulphate is more economical, as it gives just as good results with less first cost and a less quantity per gallon. In cleaning out my settling basin I used to have 2 ft. of sludge on the bottom of the basin every two months. I have now 8 ft. of sludge on the bottom of the basin in the same time. The sludge is where it belongs, instead of being on the filtering beds, where it necessitated considerably more frequent washing.

The principal trouble with our plant, and the majority of filtering plants that I have visited, is that they are nearly all short of sufficient settling basin area, this being too small for the capacity of the filter beds. This is occasioned, I think, principally by the seeming large first cost, and also by most of the filter manufacturers telling the purchaser that if he has the basins too large he will not get enough flock on the filter beds to make a good filtering mat. My experience is that (within certain limits) the clearer the water goes on to the filter beds the better. I would allow at least two hours of sedimentation, since with this amount there will be plenty of flock carried onto the beds to make a good mat. The process of settling coagulated water takes out much matter in suspension, and also a large proportion of the bacteria before it goes on the beds. The smaller amount of suspended matter save wash water, as it allows the beds to run longer without being disturbed.

There were times before I commenced the use of lime with the alum or iron sulphate that I have washed the beds every six hours for two or three days. Since using lime, I have never washed the beds more than once in 24 hours, and most of the time once in 48 hours. When it is considered that this is done in purifying a raw water that at times will give ¾-in. of suspended matter in a ½-gallon bottle, you can see that there is fast sedimentation accomplished.

I wash my beds at the regular intervals, either every 24 or 48 hours with air and water for 15 minutes (or until clear); then with water for five minutes, and then let it filter to waste for five minutes.

I make a practice of washing all the beds once a month, outside of the regular washings, for six hours at a time with air and water.

I keep a daily record of the turbidity, alkalinity and color of both of the raw and filtered water. I also test frequently to see that I do not get a caustic alkalinity by the use of too much lime.

Our bacterial removal is from 96 to 98%, and this is about as good as can be done from day to day with any filtering plant.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, Champaign, Ill., Jan. 15, 16, 17, 1908.

†Superintendent of Water-Works, Kankakee, Ill.

A JACK-TESTING MACHINE of lever type for testing the actual lifting power of portable jacks has been installed by the Joyce-Cridland Co., of Dayton, O. The company for many years tested its jacks in a hydraulic machine in which the load lifted by the jack was indicated by a pressure-gage. It was noticed, however, that under heavy pressure, indications on this machine were not accurate for it would show loads in excess of the load mathematically possible, even assuming that there was no friction within the jack. After careful investigation the difficulty was found to be in the pressure gage of the testing machine, and upon taking the matter up with the gage manufacturers, it developed that the latter were not prepared to furnish gages of greater guaranteed accuracy.

The company therefore installed a 16-ft. beam fulcrumed at one end and weighted at the other with 850-lb. weights, of which from one to eight may be used. By setting the jack at different points under the beam and using various combinations of weights, any jack made from the largest to the smallest may be accurately tested.

NEW INTERLOCKING PLANT, HOBOKEN TERMINAL YARD, DELAWARE, LACKAWANNA & WESTERN RY.

A new interlocking plant which exhibits some novel features tending toward greater safety and dispatch of operation has just been put into service by the Delaware, Lackawanna & Western Ry. at its terminal station at Hoboken, N. J. The plant controls all movements of trains in and out of the terminal train-shed, over a track system connecting 14 terminal tracks in the train-shed with the four line tracks.* Briefly, it comprises 36 switches or sets of switches and 110 signals, operated by compressed air and set from an electro-pneumatic interlocking machine of 131 levers (99 active, 32 spare). All switches are guarded by detector track-circuits in place of detector bars. These circuits are supplemented by intermediate track-circuits between the switch-detector circuits, so that the entire terminal yard is covered. Four groups of route signals divide the yard outside of the terminal shed into four sections. Each signal is valid for its entire section, to the next signal. Correspondingly, the track-circuits in each signal section are so connected through their several relays and the interlocking machine that, when a route through the section has been set, and the train has entered upon it, all switches in the entire route ahead of the train are locked, and remain so until the train has passed completely into the next section. But at all times those parts of the route which the train has already passed become automatically *unlocked* and free to be set for another route. This latter is the distinctive feature of the present plant.

The purpose of this plan of unlocking an occupied route close behind the train traversing the route is to permit other trains on diverging, converging or intersecting routes to use tracks and switches as soon as the first

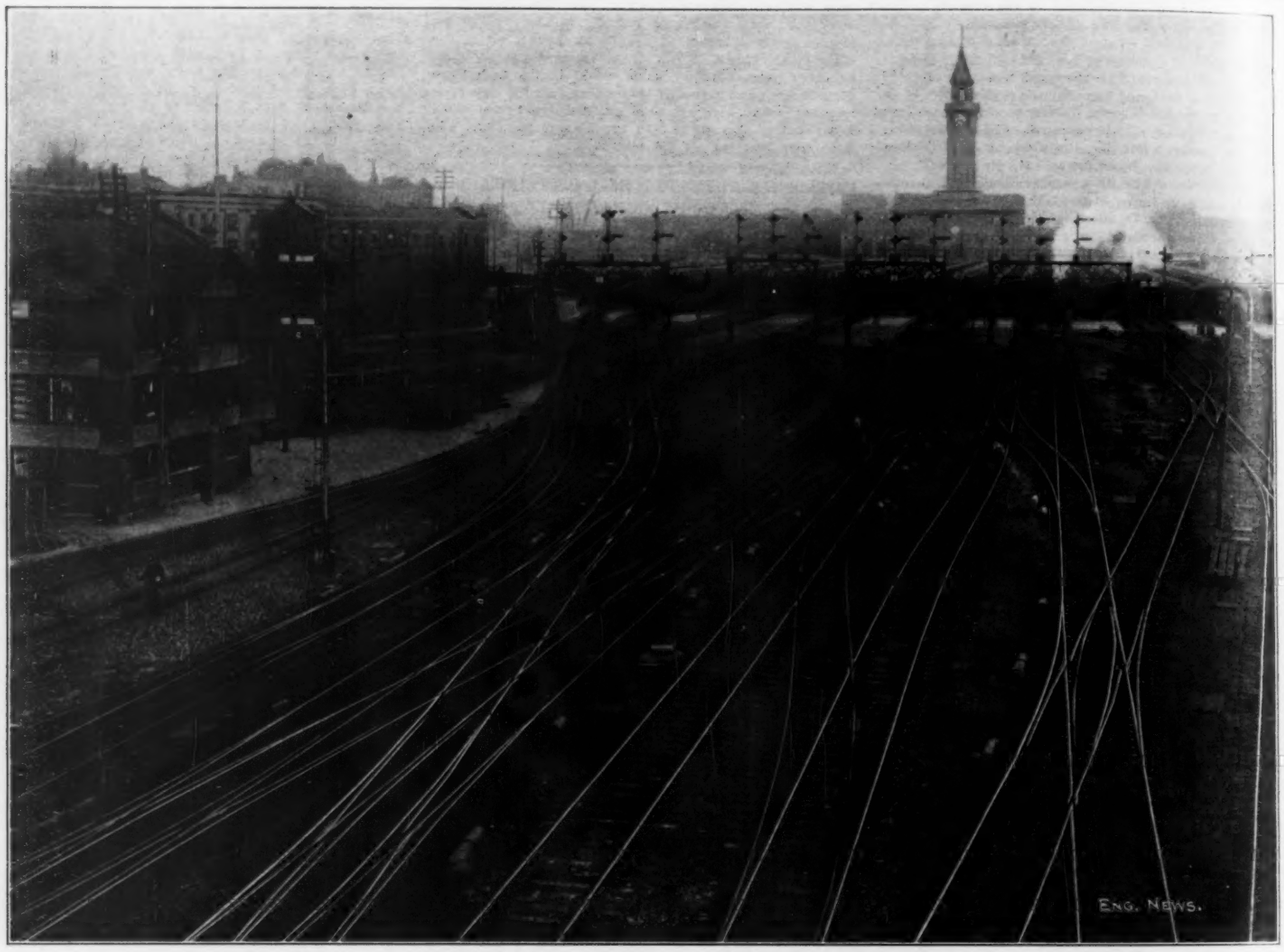


FIG. 1. VIEW OF EAST PART OF INTERLOCKED TERMINAL YARD AT HOBOKEN, N. J., DELAWARE, LACKAWANNA & WESTERN RY.

Looking east from Signal Bridge No. 5. The interlocking tower is seen at the left margin.
Two double-slip crossings with movable-point frogs are in the immediate foreground. These frogs are operated by the machine operating one of the two sets of switch points.

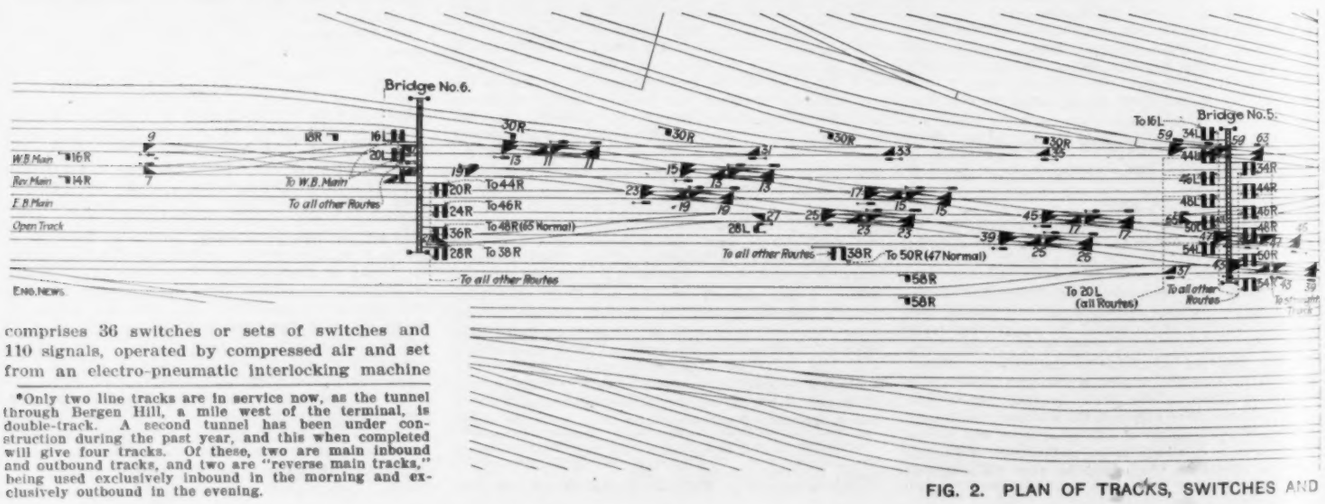


FIG. 2. PLAN OF TRACKS, SWITCHES AND

*Only two line tracks are in service now, as the tunnel through Bergen Hill, a mile west of the terminal, is double-track. A second tunnel has been under construction during the past year, and this when completed will give four tracks. Of these, two are main inbound and outbound tracks, and two are "reverse main tracks," being used exclusively inbound in the morning and exclusively outbound in the evening.

train has cleared them. The importance of the time-saving thereby secured is especially apparent in the case where it is not possible to set a route clear through the yard at once, and a train entering upon the first section is held at the end of the section until the following section can be set. In this case all tracks intersecting the route set would be blocked until the first train has proceeded entirely out of the section. On the other hand, the present arrangement enables the tower operators to utilize the cleared track behind the train. In fact, the exigencies of traffic operation in a large terminal yard having complicated track lay-out, frequently with step-by-step movement of trains and with many shunting or drilling movements, are such that the adoption of a route-locking system has been practically impossible hitherto, in the absence of an automatic clearing arrangement as here used.

The track arrangement of the yard is represented by the switch and signal plan Fig. 2. North and south of the western half of the yard is a series of coach tracks; north of the eastern half are express tracks and milk-train tracks, while to the south are a coach yard, immigrant, service, Pullman tracks, etc. Wherever these outer tracks enter the interlocked yard, they are of course cut off and protected by interlocked signals. A view of the easterly half of the yard is given in Fig. 1, reproduced from a photograph taken at signal bridge 5, looking eastward. The interlocking tower is seen at the left in this view.

The interlocking machine, located in the upper story of the tower, is shown by the photographic view, Fig. 5. Its general construction is the one typical for electro-pneumatic machines, but certain modifications were made to suit it to the more complex functions required in the present plant. Referring to Fig. 5, the upper levers are the switch-operating levers, standing normally to the left, and for reversed position to the right. (In the track plan, Fig. 2, where the switches are indicated by triangles, the direction of the long side of the triangle indicates the track for which the switch is normally set.) The lower levers operate the signals. These are normally in the vertical position, which sets both inbound and outbound signals at danger; pulling to the left clears the signal in one direction and locks the opposing signal, pulling to the right the contrary (if one position of the lever controls more than one signal, the setting of the switches "selects" the appropriate signal).

The lever shafts in the machine run horizontally from front to back. In the front half they engage the interlocking bars, while in the rear half they carry the electro-magnetic locks (one for normal, the other for reverse setting) and the contact springs for the operating and indicating circuits. The electric lock circuits are not connected when the lever is at rest, being held open by a mechanical detent latch on the lever handle; when the detent is pressed, preliminary to moving the lever, the lock circuits are closed at the latch, and if both the detector and the route-locking relays are closed, the lock magnet is energized and withdraws the lock, thereby releasing the lever for the desired movement. The horizontal shafts of the machine were not long enough to take the numerous additional contact springs required for the route-locking circuits, as the machine was designed before the use of route-locking had been decided upon. A set of vertical shafts was, therefore, added at the rear of the machine, geared to the horizontal shafts and rotating with them. The route-locking contacts are mounted on these vertical shafts; they are accessible through removable panels at the rear of the machine. The other contacts, the locks and the interlocking bars are accessible through the removable glass panels which cover the machine.

A further addition made to the machine is a set of small monitor lamps, one for each switch, mounted under a glass ledge board at the bottom edge of the front of the machine, each lamp directly below the corresponding switch lever. Each lamp is in circuit with the electric lock circuit (but shunted around the latch cut-out), so that the lamp is lighted up whenever the corresponding switch is unlocked, but becomes dark as soon as the lock goes into action, whether because of the presence of a train on the switch detector circuit or because of the automatic locking of an entire route through the switch. The auxiliary equipment of the interlocking tower will be mentioned farther on.

Turning now to the track and its protective circuits: In order to show how the detector circuits and the supplementary track circuits are arranged, Fig. 3 is given, representing the rail sections in the eastern portion of the yard, and typical for the entire yard. The heavy lines indicate the insulated sections, to which the positive side of the track battery is connected. In general, the detector circuit of a switch extends from just ahead of the point of the switch to the fouling point, located a sufficient distance beyond the frog, in both main track and turnout, so that cars on the two tracks will clear each

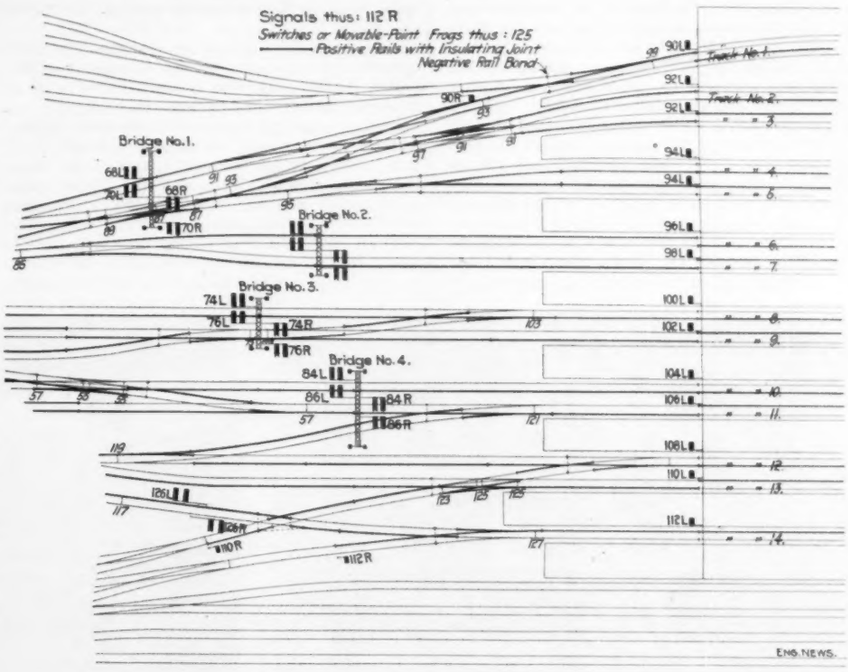
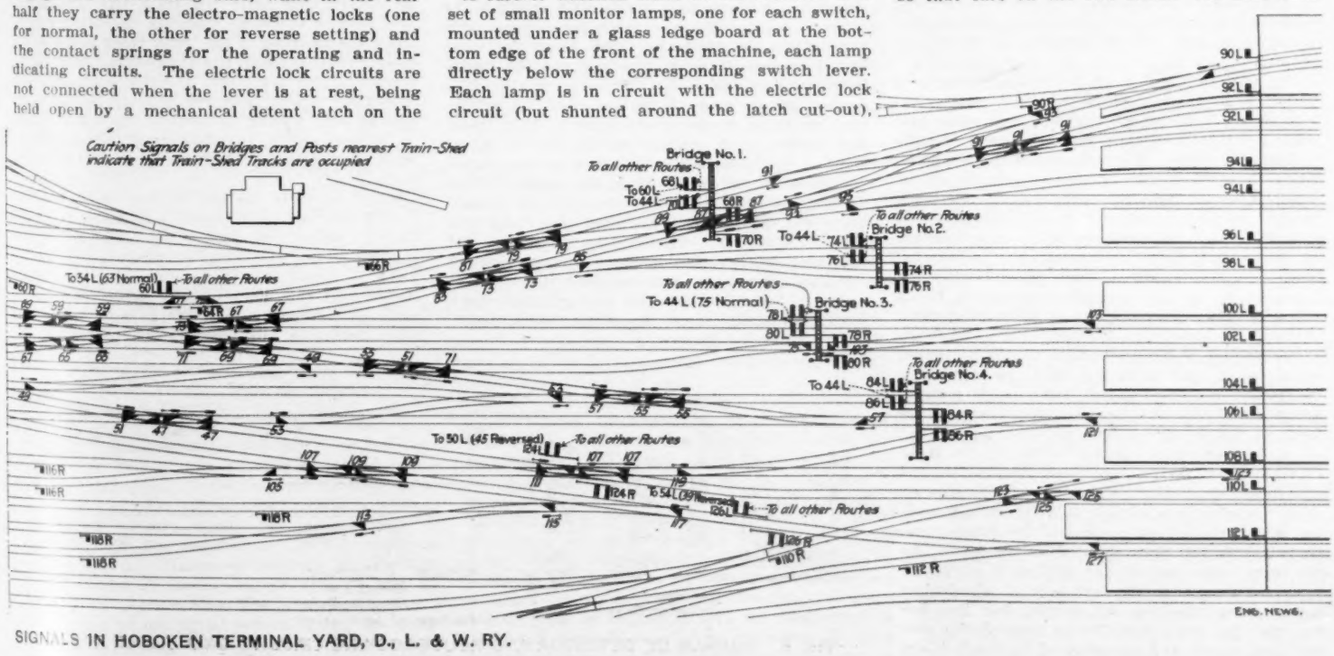


FIG. 3. DIAGRAM OF TRACK CIRCUIT SECTIONS IN A PART OF THE TERMINAL YARD.


Caution Signals on Bridges and Posts nearest Train-Shed indicate that Train-Shed Tracks are occupied
Bridge No. 1.
Bridge No. 2.
Bridge No. 3.
Bridge No. 4.
To all other Routes
To 44 L (75 Normal)
To 50 L (45 Reversed)
ENG. NEWS.

SIGNALS IN HOBOKEN TERMINAL YARD, D., L. & W. RY.

other. Where two straight tracks intersect, and have curve rails connecting them, so that there is a facing switch in both directions, the section includes only the switches and crossing, but through the levers of the interlocking machine it is connected with the following section, extending to the fouling point in both tracks. This is done by breaking the detector circuit through the track relays of these sections, the proper following section being selected by the motion of the switch lever; thus, if either of the two relays is short-circuited by a train it breaks the lock circuit and holds the switch lever locked.

The direct connection of the track-circuit relays through the switch levers is adequate to thus keeping locked the remaining portion of the route.

This relatively simple arrangement is much complicated, however, by the necessity of providing for running over a given route in either direction. When running east, for example, the automatic clearing of the switches must proceed in from west to east, while for a westerly movement the clearing must proceed in the reverse order, although the various switch levers being in the same position in both cases, the circuits are grouped in the same way. To accomplish this, two route-locking relays are used, one for either direction, and the setting of the signals is made to select the proper one of these relays

When the route is set by the switch levers at the tower, the stick-relays being permanently connected to the detector relays of the westerly and easterly track sections, respectively, are in the lock system. Upon setting the signal lever for eastbound movement, that stick circuit of the eastbound relay is broken. This in itself accomplishes nothing toward locking the route, as the relay is still held closed by the track relay at the west end of the route. But when a train enters this westerly section, it opens the track relay, which opens the other circuit through the winding of the stick-relay and thereby drops the armature of the latter. This action, directly or by breaking the circuits of

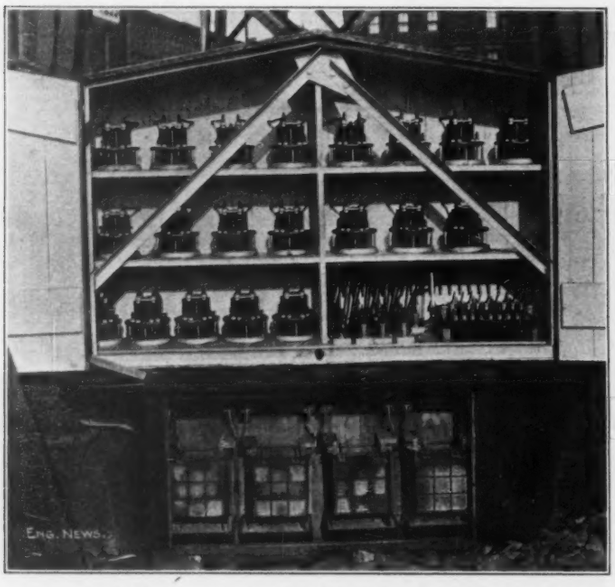


FIG. 4. TRACK BATTERIES AND TRACK RELAYS IN BOX AT BASE OF SIGNAL BRIDGE.

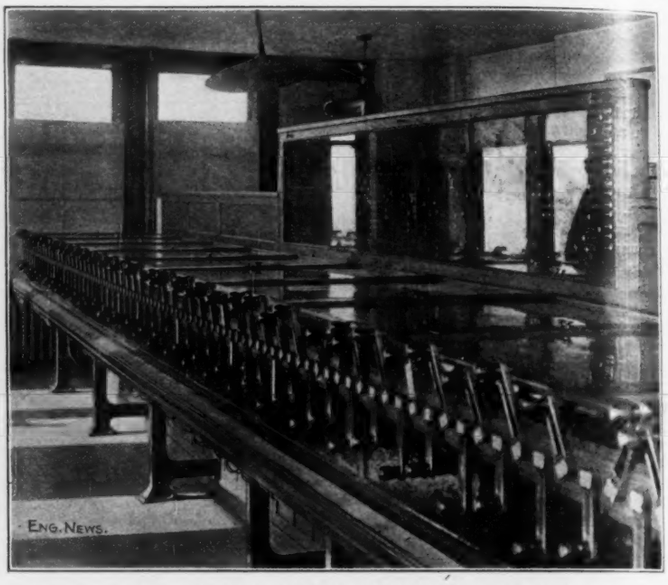


FIG. 5. THE ELECTROPNEUMATIC INTERLOCKING MACHINE OF 131 LEVERS AT THE HOBOKEN TERMINAL, D., L. & W. RY.

protect a train both against throwing a switch under the train and against the possibility of any other train being permitted to come within the fouling limits and thus colliding with the first train. The mechanical interlocking within the machine, on the other hand, prevents setting switches for intersecting or opposing movements, or setting signals in opposition to a movement for which switches have been set. Neither of these devices provides for the route-locking and clearing, which is accomplished by another series of electric locking circuits, as will be explained.

The essential device of the route-locking and clearing circuits is a route-locking or master relay, of which there are two for each route and each integral part of a route between signals, in both directions. Through one of the armature contacts of this relay passes a battery circuit which goes through the armatures of the track relays and switch detector relays in series, and thence through the windings of the lock magnets of the switch lever controlling the switch included in that section. Each relay having six contacts, it can be connected separately in as many switch-locking circuits as it should govern. When the master relay is de-energized and drops its armature, it thus opens all the lock circuits of the route, and locks the whole route. When the master-relay is closed, however, it permits all the lock magnets to clear their switches as soon as the track detector circuits, up to that piece of track which is occupied by a train, have cleared their relays; the lock-circuits beyond this are broken either in the lock circuit directly or in the energizing circuit of a succeeding master relay, by the open contact of the detector relay which is just then shunted by the train. As the train passes out of this section, it allows its relay to close after the last pair of wheels has passed, thus releasing its switch; but just before this the train has already entered the section just ahead, and has shunted its track relay, by a peculiar arrangement of the circuits, in the following manner:

Taking the eastbound route-locking relay as an example, we find that its windings are supplied by two distinct battery circuits connected in parallel. The first of these goes through the armature of the relay connected to the (one or more) track-sections at the west end of the route; when a train enters the westerly section, therefore, it opens this circuit, and provided the other circuit is also open (as will be shown, this can occur only when the signal is set for eastbound trains), it drops the lever of the route-locking relay and locks the entire route. The second circuit goes through one of the armature contacts of the route-locking relay itself, and thence to a contact spring on the signal lever at the west end of the route; this circuit is closed at the lever when the signal is set against eastbound movements, and is opened when the signal is set to "clear" for eastbound trains. Since the circuit passes through the armature of the relay itself, it cannot close or "pick-up" the relay, but can hold it closed, or make it "stick" when the first circuit opens. This stick action gives the name "stick-relays" to the route-locking relays.

succeeding stick-relays, breaks the series lock-circuits through all the switches on the route, and locks the route.

After the train has entered upon the route, the leverman in the tower throws the signal back to danger, to close the route against a following train. This motion of the signal lever restores the stick circuit, which, however, is unable to cause the stick-relay to pick up. Picking up occurs only after the train has passed the first part of the route (usually the first switch), when the clearing of the track relay restores the main circuit through the stick-relay. The latter, attracting its armature, thereby completes the unlocking circuit, and this circuit becomes active at each switch as soon as all track relays up to that switch are cleared; thus the route is successively unlocked behind the advancing train.

When the train reaches the last (easterly) section of the route, the special purpose of the stick circuit comes into action, by preventing the opening of the westbound stick-relay. The latter being in closed position, requires both the stick circuit and the main circuit through the track relay to be opened in order to drop the stick-relay armature and lock the route behind the

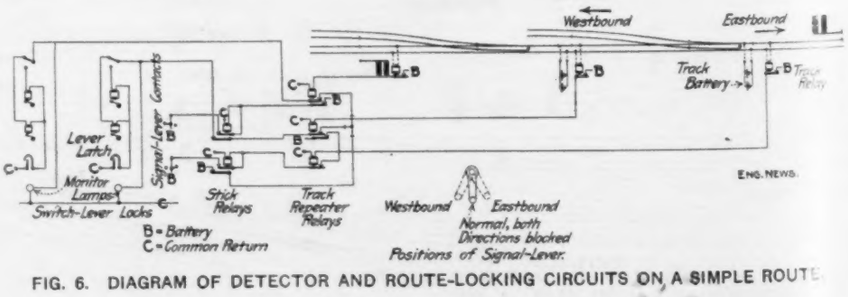


FIG. 6. DIAGRAM OF DETECTOR AND ROUTE-LOCKING CIRCUITS ON A SIMPLE ROUTE.

train. ... the signal lever, set for eastbound movement, keeps closed the stick circuit of the westbound relay; consequently, the opening of the main circuit through the latter by the track relay does not open the stick relay, and the eastbound progression of the unlocking is left undisturbed. As soon as the train has passed completely out of the route, the last track relay is restored and thus the last switch is unlocked. The route is, therefore, free to be set either in part or as a whole for any movement in either direction, consistent with the setting of the switches on intersecting routes (which act by way of the mechanical interlocking).

To make the arrangement and operation of this mechanism clear by a graphical example, the circuits for a simple route of three sections, with two switches, are shown in the diagram, Fig. 6. In this case, eastbound and westbound signals are operated by a single lever, the corresponding positions being indicated by an auxiliary sketch in Fig. 6. The signal lever has two sets of contacts for the stick-circuits, one for each of the two route-locking relays; the two sets of contacts are of necessity shown separately.

As a further illustration, an actual part of the circuits used in the Hoboken yard is represented by the diagram Fig. 7, which circuits control train movements in either direction between Tracks 1 and 2 of the train-shed and signal-bridge No. 1. The track is shown in the upper part of the diagram, with the numbers of the track-circuit sections, the switches and the signals noted in their proper places. Only one of the track relays is sketched, namely that for detector section 10, with its repeater relay (the repeater relays being grouped in the tower, so as to give short wire connections); the other track sections are represented in the circuit diagram only by their numbers, and by the dash-and-dot reference lines which indicate where they are connected in the lock circuits.

This piece of track comprises one single switch (99) and two crossovers (91 and 93), the latter being each operated as one switch. There is a further switch, 97, which deflects an incoming train into either track 2 or track 3. This switch, being not involved in most of the movements, has been omitted in the lock-circuits. It is locked by stick-relay 97 E and by its proper detector relays.

The lock circuits of the other three switches are shown by the three horizontal lines at the bottom of the diagram. Where a cross is marked on any one of these lines, the lock circuit passes through an armature contact of the relay whose number is noted directly above, so that when this relay is de-energized and drops its armature, it breaks the lock circuit and thus locks the switch. For example, switch 99 is locked when either track relay 10, track relay 11, or stick-relay 93 E is open.

The connections through the track repeater relays, in the left half of the diagram, form the detector or the "absolute" locking of the corresponding switches, while the connections through the five stick-relays at the right form the route-locking. In the route-locking circuits, the numbers denoting the several detector relay contacts, switch-lever contacts and signal-lever contacts are inserted in the circuits in place of sketching in the contacts themselves; inclined numbers denote track relays; light vertical numbers denote signals, and heavy vertical numbers denote switches, while the stick-relays are numbered in shaded lettering.

The path of the current will be readily understood, thus: Stick-relay, 91 W, is energized from the battery over two circuits in parallel: (1) The stick-circuit through contacts on signal lever 92 when this is in normal position or to the right [i. e., referring to the track plan, when train-shed tracks 2 and 3 are blocked against westbound movement; when either track is cleared for a departing train, the stick-circuit is broken]. (2) The main circuit, which passes in series through armature contacts on the detector-relays of track sections 230, 31 and 32. Thus, when a train departing from Tracks 2 or 3 in response to the signal (which opened the stick-circuit) enters on track section 230, the main circuit also opens, therefore stick-relay 91 W opens and breaks the lock-circuits of switches 93 and 91, locking their levers in whichever position they occupy at the time, and extinguishing their monitor lamps.

On examination of the route-locking circuits in Fig. 9 it will be found that the five stick-relays have the following functions:

91 W: For westbound from signal 92 L [track 2 or 3] to signal-bridge No. 1 [to either signal 68 L or 70 L]. Locks switches 91 and 93 until the train clears track-section 32; thereupon, the stick-relay closes, but the detector circuits still hold; if the train is bound for signal 70 L, detector 52 holds switch 93 locked, but releases 91, while, if the train is bound for signal 68 L via the crossover, detector 12 holds both 91 and 93 locked, and the final section 13 holds only 91 locked.

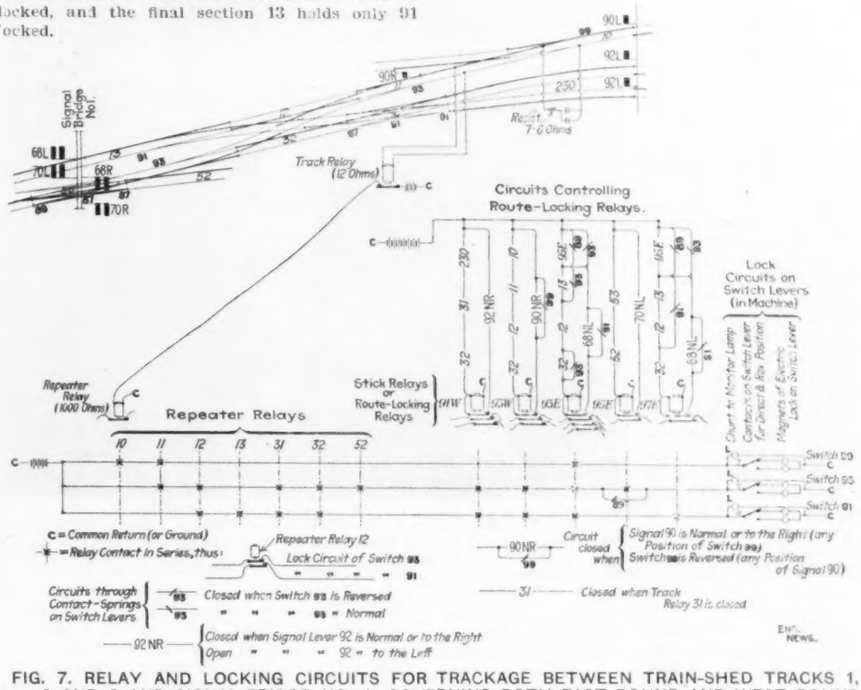

Signal Bridge No.1
Track Relay (12 Ohms)
Circuits Controlling Route-Locking Relays.
Lock Circuits on Switch Levers (in Machine)
Repeater Relay (1000 Ohms)
Repeater Relays
Stick Relays or Route-Locking Relays
C = Common Return (or Ground)
= Relay Contact in Series, thus:
Repeater Relay 12
Lock Circuit of Switch 93
Circuits through Contact-Springs on Switch Levers
Closed when Switch 93 is Reversed
Closed when Switch 93 is Normal
Closed when Signal Lever 92 is Normal or to the Right
Open " " " 92 " to the Left
Circuit closed when
Signal 90 is Normal or to the Right (any Position of Switch 99)
Switch 99 is Reversed (any Position of Signal 90)
Closed when Track Relay 31 is closed
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FIG. 7. RELAY AND LOCKING CIRCUITS FOR TRACKAGE BETWEEN TRAIN-SHED TRACKS 1, 2 AND 3 AND SIGNAL-BRIDGE NO. 1, GOVERNING BOTH EAST BOUND AND WEST BOUND TRAIN MOVEMENTS; D., L. & W. TERMINAL AT HOBOKEN, N. J.

93 W: For westbound from signal 90 L [track 1] to signal-bridge No. 1 [to either signal 68 L or 70 L]. Locks the route only when switch 99 is set for the straight track [normal]. Locks switches 91 and 93 until train clears track-section 12 on the route to signal 68 L, or track-section 32 on the route to signal 70 L. Over the rest of the route, the stick-relay is out of action, but in the absolute locking section 13 locks switch 91 if the train is bound for 68 L, and section 52 locks switch 93 if the train is bound for 70 L.

95 E: For eastbound from signal 70 R to the easterly end of track-section 52, and thence [by 95 E being connected in the battery-circuit of succeeding stick relays] to train-shed tracks 1, 2, 3, 4 and 5. Locks switch 93 only when switch 89 is set normal, i. e., for the straight track, and locks other switches on these routes under certain conditions, as will be seen from the following:

93 E: For eastbound from either signal 68 R or 70 R to train-shed track 1. Locks switches 91, 93 and 99 from the moment the train passes signal-bridge 1 until it clears section 12. On the rest of the route, switch 93 is locked in the absolute locking by section 11, and switch 99 by both 11 and 10. Note that signal-lever 68 R acts on this relay only when switch 91 is set for the straight track, so as not to lock switch 99 on a movement from signal 68 R to track 2; that signal-lever 70 R is effective only when switch 89 is normal and 93 reversed, i. e., for movement from 70 R to track 1 only; section 13 acts on the stick-relay only when switch 93 is set for the straight track, so that, for example, a westbound train on section 13 will not hold locked a route set from 70 R via the crossover to track 1; and that section 32 is ineffective when switch 93 is set for the straight track, so that when signal 68 R is cleared for an eastbound movement to track 1, the relay will not be affected by a train either eastbound or westbound between track 2 and signal 70.

97 E: For eastbound from either signal 68 R or 70 R to track 2. Locks switch 91 from the moment the train passes signal bridge 1 until train passes section 32. On rest of route, switch 91 is locked in the absolute locking by detector circuit 31. When train is entirely in section 230, the route is cleared. Note that stick-relay 95 E is shunted and therefore without effect on 97 E, unless switches 89 and 93 are both normal, i. e., unless switches are set for a train from signal 70 R straight to track 2; that the contacts to detectors 12 and 13 are shunted when switch 91 is set for the straight track, so that when a train passes from signal 70 R to track 2, this stick-relay will not interfere with a westbound movement from track 1 to signal 68 L; and that signal-lever 68 is effective in this stick-circuit only when switch 91 is set for the crossover (i. e., for movement 68 R to track 2), but not when switch 91 is set for the straight track (i. e., from 68 R to track 1). In the latter case the relay acts only through signal-lever 70 R through stick-relay 95 E, switches 89 and 93 being set for the straight track; while a simultaneous movement from 68 R to track 1 is taken care of by stick-relay 93 E.

The circuits illustrated by Fig. 9 are for the most part permanent connections of the several relays. The absolute locking, by the track repeater relays, is necessarily connected permanently in the lock-circuits of the respective switches. The stick-relays, having specific localized duties, are also connected permanently in the lock circuits, and have the track repeater relays connected permanently in their winding circuits. The only connections in the route-locking which are made by the interlocking machine are those of the switch shunt circuits and the signal-lever stick circuits.

The operation of the interlocking plant is conducted by a train director, assisted by several levermen. The former receives information about outgoing and incoming trains by indicators, and communicates with the station, the yardmaster's office, the roundhouse and the coach yard by telephone. The levermen set routes in accordance with his directions. They are able to follow the progress of trains over the various switches

by means of the monitor lamps already mentioned. When they have set a route and a train enters upon it, they are required to restore the starting signal to danger as soon as the train has cleared the first switch. The route thereupon automatically unlocks itself behind the train, as explained.

The train director's position is shown by the view Fig. 8. The telephone switchboard has connection to the various points already mentioned. The dial indicators on either side are for exchanging information as to incoming and outgoing trains with the interlocking tower at Grove St., half a mile to the west, which tower commands the eastern end of the Bergen Hill tunnel and itself receives information about incoming trains from a tower at the west end of the tunnel. These dial indicators operate by a step-by-step mechanism, actuated by turning the dial of the transmitting indicator to the number denoting the train approaching. A corresponding number of electrical impulses is thereby sent over the connecting wire and the receiving dial is moved around to show the same number.

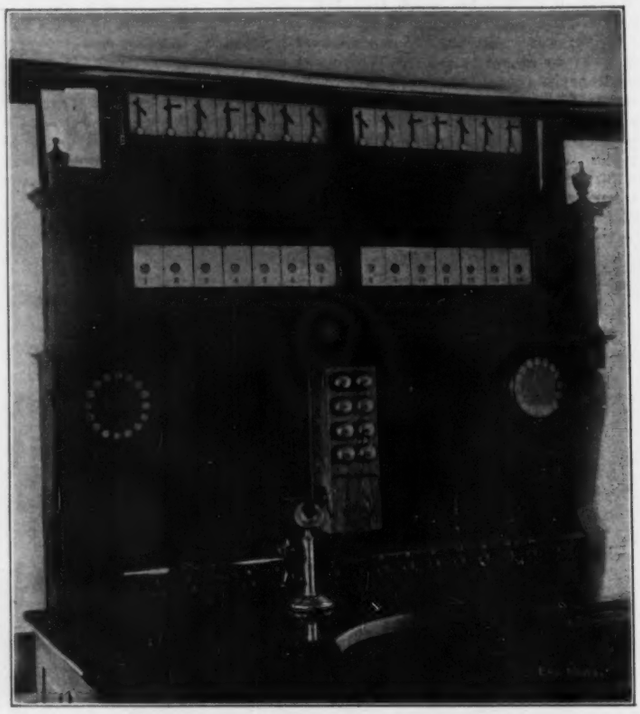

FIG. 8. TELEPHONE SWITCHBOARD AND TRACK INDICATORS, AT TRAIN DIRECTOR'S POSITION IN INTERLOCKING TOWER.

The condition of the train-shed tracks, as to their readiness for receiving incoming trains, is pictured by the row of miniature semaphores at the top of the panel, Fig. 8. When any track, say track 4, is occupied by a train, the shunting of its track-circuit throws up the indicating semaphore No. 4. When the semaphore is down, therefore, the track is clear to receive an incoming train. But in order to accommodate single cars which may lie in the terminal, waiting sleepers, for example, the track-circuit is made to extend only to a point two car-lengths from the bumping-posts. A single car or two cars may, therefore, stand at the inner end of each track without throwing the indicator.

The series of small circles below the semaphores in Fig. 8 contains numbered drops, one for each track of the train-shed, which communicate with push-buttons placed at the inner and outer ends of the track. When a train is ready to go out, the conductor pushes one of these buttons; this drops the correspondingly numbered indicating shutter in the tower.

As an assistance in the operation of the interlocking machine, an accurate model of the interlocked yard is mounted over the machine, as shown in Fig. 5 and more clearly in Fig. 9. The switches of this model are thrown by the movement of the actual switches in the yard. The electric "indication" circuit, which returns from the switch to the interlocking machine, must be energized by the actual moving of the switch in response to the movement of the lever before the lever-movement can be completed. But the last part of the stroke of the lever shifts the switch of the model, by a direct mechanical connection. The condition of the model therefore shows the actual state of the switches at all times.

The arrangement of the accessories of the signal plant can be summarized briefly. The track relays and the track batteries are grouped in boxes built in the foot of the posts supporting the signal-bridges. These relays are not used directly for the locking circuits, but are each "repeated" by another relay in the interlocking tower (see Fig. 6, "Track repeating relays"). The repeating relays and the stick-relays are mounted in racks on the mezzanine floor of the tower, directly below the machine, thus giving the shortest possible length of wiring.

The wire circuits from the tower to the various switches, signals and relays are run through a conduit of vitrified duct laid in cement, 2 ft. below the ground surface. The maximum size of this conduit is five-duct. Adjacent to this is a single-duct conduit carrying the power wire from which are fed the signal lamps, and also a wire for charging the track batteries. This wire leads from a motor-generator set in the lower story of the tower to the various battery boxes. Each track-battery group consists of two sets, one of which has its cells connected in parallel and lies across the track, while the other has its cells in series and is connected to the charging wire. A switch in the box enables the signal maintainer to interchange the two sets at one moment. This is done every two or three days, so that the cells are always well charged.

The wire conduit leads into a manhole, containing a sump or drip-box, at each signal bridge and at intermediate points. Short runs of duct distribute the wires from these manholes.

The relays and the operating and lock circuits belonging to the interlocking machine are supplied by a battery of 16 cells of 440 ampere-hours capacity each, used in two groups of 8 each, of which one is being charged while the other is in use. A motor-generator set of 3-KW. capacity, changing the 60-cycle current of the yard power-plant into 60-volt direct current for charging, supplies these batteries. In addition there is a ½-KW. motor-generator set producing 20-volt direct current, for use on the operative circuits direct, in case there is trouble with the batteries.

The switches and signals are operated by pneumatic cylinders controlled by electro-magnetic valves. Air is supplied to them at 90 lbs. per sq. in. by an air line of 2-in. pipe, extending from the power-house through the yard. This pipe is buried 12 ins. below the ground surface, and is fitted with drip boxes at the sags to trap condensation. This pipe line is supplied from compressors supplemented by two large reservoirs at the power-house.

The plant thus briefly sketched was designed in its general outlines and installed by the Signal Engineer's Department of the Delaware, Lackawanna & Western Ry., Mr. Lincoln Bush, Chief Engineer, and Mr. M. E. Smith, Signal Engineer. The work of installation was in charge of Mr. W. B. Weatherbee, Chief Signal Inspector. The Union Switch & Signal Co., of Swissvale, Pa., designed and built the interlocking machine and furnished all signals and switch mechanism.

THE RAILWAYS OF JAPAN are being taken over by the Government. The terms of purchase are substantially, 20 times the average of the net profits for the years 1902, 1903 and 1904, divided by the cost of original construction and multiplied by the same at date of purchase.

EXPORTS OF IRON AND STEEL MANUFACTURES from the United States in 1907 amounted to nearly $200,000,000, breaking all records. The extent to which the foreign trade of American manufacturers has grown by leaps and bounds in the past two decades is indicated by comparison with 1887, when this class of exports totalled only 16¼ million dollars, and with 1897, when it reached 63 million dollars.

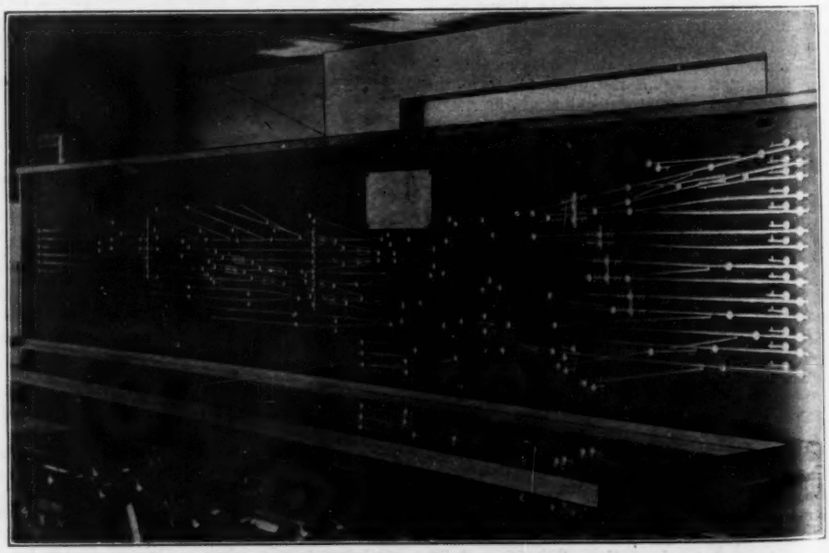

FIG. 9. TRACK MODEL OF INTERLOCKED YARD, OVER INTERLOCKING MACHINE.

The switches are operated by lever connections from the switch levers during the final half of their movement (after receiving the electric "indication" showing that the switch has responded to the movement of the lever.)

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Entered at the New York Post-Office as Second-Class Matter

The question whether the River and Harbor Improvement work ought not to be under direction of an efficient and properly organized corps of civilian engineers in place of the present control by military engineers is brought forward by a committee of the New York Board of Trade and Transportation.

Assuming that a great expansion is to take place in the amount of expenditure on waterway improvements by the Federal Government, the committee raises the question whether the present corps of engineers of the army is sufficient in number to give the needed professional supervision that would be required?

It points out that the total number of officers of all grades in the corps is only 169, and a large proportion of these are engaged in military duties or other work aside from river and harbor improvement. These officers have long been inadequately paid for the heavy responsibilities they carry and the injustice of this has become increasingly evident since the rise of prices in the last few years greatly increased expenses of living. The civilian assistants employed have their salaries necessarily gaged at a low figure in order not to exceed the salaries of their superior officers. The committee continues as follows:

> It may also be said that Congress may take measures to expand the Corps of Engineers to such proportions as the demands of the public service will require. But even Congress lacks the power to add engineers of experience to the corps. It may increase the number to be detailed to the corps from those graduated hereafter at West Point, but, at best, they will for years to come be inexperienced and not such as any railroad company or business corporation which is conducted upon sound business principles would entrust with the planning or construction of works of even moderate cost. We feel confident that a very radical change in the whole system of the management of river and harbors improvements should be made without delay, and to that end we would propose that a new department of the general government be created, with a cabinet officer at the head, to be known as the Department of Public Works, or some appropriate title, to have charge of all river and harbor construction and all that relates to the initiation, examination, survey, planning and construction of such works.
>
> We believe that such new department suitably constituted and equipped, would be the instrument which by properly investigating projects and defining their national or local character, would eliminate the evil of the log rolling scrambles for appropriations, and insure for those projects which would be approved their proper construction under competent engineers selected from civilian members of the engineering profession.

Many of our older readers will remember the agitation which was carried on some twenty years ago among engineers, particularly in the West, looking to the transfer of Federal river and harbor work to civilian engineers.

At the present time, as the above quotation indicates, there are broader reasons for a change in the organization of our Federal public works system than the mere transfer of control from an engineer educated at West Point to one educated at Troy or Boston or Ann Arbor. Whether our waterway improvement work needs to be placed under control of a separate cabinet officer, or whether it should be transferred to the Department of Commerce and Labor, is a question that might be worth consideration; but certainly some organization is needed which can effectively and adequately initiate and plan waterway improvements, which can bring to the attention of Congress and of the public such as are most deserving, and which can without fear or favor condemn those which are unjustified for public reasons.

We trust that the Federal Waterways Commission when it presents its report may give due attention to this important matter of organization, since it lies at the very basis of the proposed radical enlargement of the scope of Federal waterway improvements.

The transfer of the work of waterway improvements to a separate bureau ought not to be any reflection on the officers of the Corps of Engineers. It would be difficult to overestimate the debt which the nation owes to this eminent body of engineers for the high character of the service they have rendered. In fact, there will certainly be strong opposition on the part of very many able men in public life to any displacement of the engineer officers. It is generally felt that these men can be implicitly trusted for honest and impartial treatment of all matters in their control, unswayed by any questions of corporation influence or local rivalry.

The fact that the work at Panama is being ably carried on under engineer officers, after repeated changes of the civilian engineers originally in charge will be a heavy handicap to any proposal to put civilian engineers in control of river and harbor work. On the other hand, the Federal Reclamation Service has proved the possibility of creating a Government engineering organization that will be free from political influence, local prejudice or graft. It should be possible (with equal backing from the Administration to that which the Reclamation Service has received from President Roosevelt) to create a body of river and harbor engineers of as high standing as that brought together under Mr. Newell in the Reclamation Service.

The final abandonment of cable traction on the Brooklyn Bridge railway, which took place on Sunday, Jan. 26, is worth especial note, since cable traction has survived here for a full decade after the electric motor had driven the cable from the field almost everywhere else. A good reason for its survival is the long grades on the bridge approaches. With the cable system the trains running down the grade at one end furnished part of the power required to haul trains ascending the grade on the opposite approach. More important still from the point of view of safety in operation, the cable system furnishes an automatic means of spacing the trains, and in descending the grades there is no chance of one train gaining in speed and colliding with the one ahead. Many conservative engineers have contended that this feature alone made it worth while to retain the cable in service.

It is interesting to recall the fact that when the Brooklyn Bridge was opened to traffic in 1884, cable traction was the accepted system for moving street cars. Cable street railways were in service in every progressive city of large size and their mileage was rapidly being extended. The electric railway was still in the stage of experimentation and preliminary development. The Brooklyn Bridge engineers of that day, in adopting the cable system, chose the best method then available for the movement of their cars. In the application of the cable system to the bridge railway, however, heavy trains had to be handled, while existing cable roads in city streets were moving only light single cars, little heavier than the horse cars which they had replaced. It was necessary, therefore, to work out a special system of grips and mechanism for catching and releasing the cable at the terminals.

All this was done with great success, as our older readers will well remember; and no one can deny that the cable in its 24 years of service on the bridge has made a most creditable record. As has often been shown in these columns, the density of traffic on this bit of railway track between New York City and Brooklyn has for at least twenty years been far in excess of that on any other railway in the world. And this dense traffic has been handled with a freedom from accident that is almost without a parallel.

It is, indeed, a tribute to the excellence of the cable system that it has survived so long after the partial introduction of electricity. The equipment of the bridge cars with electric motors, so that they could move themselves in switching at terminals occurred nearly a dozen years ago, and at the same time a third rail was carried clear across the bridge, so that in case the cable was out of service for any reason, trains could run by electricity alone. Not long afterwards the electric surface cars of Brooklyn began running across the bridge on tracks laid in the roadways. These cars have, of course, climbed and descended the grades all these years without the aid of a cable and the number of other cases where trains are operated by electricity on heavy traffic lines with steep grades furnished at last convincing proof that the cable might be dispensed with.

Our old friend the "United States Trade Reports" of Cincinnati, whose methods were exposed in these columns some years ago*, appears to be again doing business in the same old way. As some of our readers may recall, the scheme of this and similar journals published in the same locality, was to prepare a laudatory "write-up" of some particular concern's goods and send it to the concern with a request for an order for extra copies of the issue containing the article. The sort of matter used in its "write-ups" may be judged from the following sample, offered to one of our correspondents recently. We print it below *verbatim et literatim*, omitting only the names of the product referred to and the company.

FACTS ABOUT —— ——.

In these days of fierce competitionwhen every manufacturer is pushing his products into the market with all the energy at his command, there is often a temptation to sacrifice an element of excellence for reaching a reduction in cost. Complaints are heard regarding the infeciority of some makes of —— —— now on the market being sold as first class, also of the fact that many do not keep up with the times inthe matter and we feel that we are doing a practical service to our readers when we recommend a really meritorious article which can be relied upon.

As this paper is maintained on the principel of furnishing its readers with accurate advice we have decided to go into the matter with great care. We are aware of course that the buyer is at a disadvantage. He cannot depend on the statements of sellers, as each thinks that which he represents to be the "neplus ultra" of the manufacturers art. No journal devoted to the trade could afford to give a definate and correct answer to the question, regarding excellence, and the customers are demanding that their products shall possess a degree of quality which hhall be commensurate with the price.

The reports therefore decided to make at thorough examintaion the result of which would be a decided answer which could be relied upon by all. Every point was carefully considered and every effort was madeto cause this researchto be complete in every respect.

As a result we areprepared to state that there is no make of —— —— on the market to-day of the qualities

*Engineering News, March 6, 1902; Oct. 6, 1904.

which make for excellence superior to that produced by the —— —— —— Co., New York, N. Y.

It is a pleasure to us to give them our editorial commendation and at the same time supply ourpatrons with accurateadvice onsuch an mportant subject as this.

From a copy of the "United States Trade Reports" dated Nov. 18, we learn that its ubiquitous editor has "investigated" a "Peruvian Gold Mining Corp." which is offering "a small block of stock at 25 cents a share" and the editor, after three columns of description, says he is "convinced that this company offers opportunities which are rarely presented to American investors," and that "it appears quite feasible for a stockholder to make as big a fortune as he may wish on a small investment and yet be perfectly sure of his money."

On the editorial page of the same issue we learn that the editor has been asked to "editorially recommend the school or system which has the best and most successful record for physical culture." He says:

Realizing the importance of the subject, as also the confidence which would be reposed in our reply, we took it up as a personally conducted investigation. All leading schools, systems and methods of physical culture were thoroughly and carefully investigated.

We find that the Institute of ——, Nebraska, has the best system and method of physical and mental culture and development that is known, and this Institute has a record of success which is not held by any other school system.

The above extracts are sufficient to show the character of the journal and indicate the worthlessness of its laudatory write-ups from any possible point of view.

In a recent English publication we find the following definition: "Reinforced concrete is a combination of steel and concrete in which steel takes the tension stresses and concrete the compression."

Against any such restrictive and inaccurate definition, an emphatic protest is due. Are there no other stresses than tension and compression to be borne? What about the shear in beams? What about the present common practice in reinforcing columns, where both steel and concrete are in compression? Even though the computer may design a beam on the assumption that the steel will be sufficient to take the tensile stresses, it does not follow that it actually does take all these stresses, as the framer of the above definition assumes. Actually the concrete in the lower part of the beam is in tension, as well as the steel.

Our readers will generally recall the "confusion of tongues" that prevailed a few years ago, when "steel concrete" "concrete steel," "armored concrete," "ferro concrete" and various terms were in common use; and all will admit the gain to technical literature that resulted when practice at last settled down to the term "reinforced concrete." We understand by that term any combination of metal imbedded in concrete to form a structure so that the two materials assist each other to sustain the stresses imposed. Any narrower definition is objectionable.

When an engineer applies for a position in connection with some new enterprise and receives in reply an offer of a responsible place with a liberal salary attached, provided he subscribes to the company's stock, he will do well to investigate very critically, before he takes the bait. There may be instances where such offers are made legitimately by bona fide enterprises; but it is very seldom that any responsible concern attempts to raise money in such a way.

Similarly, requests for a deposit of money from an applicant for a position "as a guarantee of good faith," or for any other trivial reason is prima facie evidence that something is wrong. We must remind our readers that with the multitude of enterprises described in our Construction News columns and advertising in our "situations open" column, we are unable to identify irresponsible and fraudulent concerns in every case; and our subscribers should use due caution in addressing and dealing with the promoters of new enterprises.

PROPOSED CONSOLIDATION OF THE STATE HEALTH, SEWERAGE AND WATER COMMISSIONS OF NEW JERSEY.

It is a hopeful sign of the times that both the retiring and incoming governors of New Jersey have made sweeping recommendations for the consolidation of boards and commissions dealing with health, water supply and sewage disposal matters in that state. More than once we have deprecated the multiplication of such commissions in one state or another, and have pointed out reasons why the greatest efficiency in health-protective work may be expected where such work is entrusted to one strong board, having as its primary interest the health of the state, rather than having the work distributed among several boards, with as many purposes and with a strong likelihood of a conflict of interests and activities.

New Jersey now has a State Board of Health, a State Sewerage Commission, a Passaic Flood District Commission, and a State Water Supply Commission. Of these four commissions Governor Fort, in his inaugural message delivered on Jan. 21, says:

The State Board of Health and the State Sewerage Commission, which cost the state over $56,000 last year, should be united.

The laws creating these two departments are in conflict on many subjects. The Court of Chancery held in the Vineland case, that the Board of Health act was so repugnant to the Sewerage Commission act that the provisions of the health act permitting the enjoining of the pollution of potable waters, by that board, were repealed. The Court of Errors and Appeals afterward modified the decision and saved both acts, but there is still room for litigation.

The Sewerage Commission should be abolished and the Board of Health reorganized, with a medical secretary in charge, with a president and five members to be appointed, who should be reasonably compensated for their services.

The cost of this need not exceed the salaries now paid to the Sewerage Commissioners alone.

This action would insure a better result to the state and promote simplicity and efficiency in the public service.

The Potable Water and the Passaic River Flood District Commissions should both be abolished and a single-headed department established, to be known as the "Department of Water," with all the powers now conferred upon these commissioners vested in such department.

There are five commissioners on the Flood Commission, and their salaries amount to $12,500, and five on the Potable Water Commission, with salaries amounting to $5,000; a total salary account of $17,500 per year. [The salaries of the two sets of commissioners are either reversed or else the members of each receive $2,500 apiece. —Ed.]

There is no justification for this duplication of commissions, in my opinion, and one commissioner at a reasonable salary, or three if thought best, who should devote their time to the work, would save the state several thousand dollars per annum.

Much more might have been said in favor of making the changes recommended, and it would have been no very radical proposition had the governor advised that all four bodies be combined in one. Nearly all the functions exercised or authorized by these four boards have been exercised for years past by the Massachusetts State Board of Health, the chief differences being in matters of procedure, except that the New Jersey Water Supply Commission is designed to collect revenue for the use of waters appropriated by cities and companies and is authorized to construct reservoirs for water conservation and flood prevention.

The abolition of the New Jersey State Sewerage Commission, or rather merging it into the State Board of Health, should not be considered as any reflection on the commission, but rather as a step to rectify a mistake made when an independent commission was created to pass on sewage disposal plans and to conserve the purity of the public waters of the state. With the exception of a short-lived sewerage commission in Connecticut, New Jersey is the only state in the Union that has ever created such a commission. All the other states that have attempted efficient control of water pollution have entrusted the matter to their state boards of health, and there such control belongs, since it is most vitally related to the quality of public water supplies, the repression of typhoid fever and the health and mortality of the state.

Besides the conflict in the Vineland case, mentioned by Governor Fort (in which the lower court held that the State Sewerage Commission having approved sewage disposal plans the State Board of Health could not intercede in behalf of a municipality whose water supply was endangered by the improper operation of the sewage works) both the Health and the State Sewerage Commission took a hand in investigating the recent typhoid outbreak at the State Hospital for the Insane, at Trenton, and each board came out with a different theory for the cause of the outbreak (see Eng. News, Oct. 1906). Such happenings do not tend to create confidence in public boards, and seem to indicate a waste of money on the part of one board or the other.

Scarcely was the incident just mentioned closed when both the State Board of Health and the State Water Supply Commission appeared on the scene at Trenton, this time in connection with the outbreak of typhoid fever in the city of Trenton. Why the State Sewerage Commission has not also appeared we do not know. No conflict has yet arisen in this case, but with every duplication of activities by state boards confusion, if not conflict, is liable to arise.

We submit, as a self-evident proposition, that in sanitary matters a single state board should be in supreme control, and the State Board of Health, whether of New Jersey or any other commonwealth, is the one and only logical board for that purpose. If that or any other board is unequal to the task, then no time should be lost in making it efficient, be it money, legal authority or a thorough reorganization that is required.

A great drawback to efficient health-protective work in New Jersey, and until recently in New York as well, has been the starvation and undermining of existing boards and commissions by the creation of new ones. To confine our remarks on this head to New Jersey: The New Jersey State Board of Health has never had either the money or the technically-trained engineering and other technical assistance needed to carry on the sanitary research in water supply and sewerage that is needed in the state, and has made the Massachusetts Board known the world over. The New Jersey State Sewerage Commission has never had liberal appropriations for its expenses, other than salaries of members, and until recently it has done practically nothing to advance the art of sewage treatment. But for a number of years the five members of the commission have drawn salaries of $1,500 each, which, in the aggregate, when combined with the office and other expenses of the commission, would have been sufficient to enable the State Board of Health to greatly extend its work and usefulness. On top of the salaries paid the State Sewerage Commission there have, in the past few years, been put the salaries of flood commissioners, and now of water supply commissioners. These three additional commissions, with their salaries and their expenses for rent, office staff, engineers, etc., have been doing substantially the same work, as we have already stated, that for years past has been done, as occasion arose, by the Massachusetts State Board of Health. In addition, there may be noted the $12,500 a year paid in salaries to the Passaic Valley District Sewerage Commission, which, though district rather than a state charge, has thus far all gone for preliminary investigations. Like preliminary investigations, in the case of both the metropolitan water supply and sewerage systems for Boston and vicinity, were entrusted by the legislature to the Massachusetts State Board of Health. When the board had completed its preliminary work in a thorough manner, and not until then, were district commissions created.

We have mentioned only a part of the New Jersey commissions which Governor Fort has indicated for abolition or consolidation. The numerous other commissions with which the state is burdened do not concern this discussion, but they do show the necessity of radical reform in New Jersey. We fear they indicate the difficulties of reform, as well, for it is one thing to create and quite another to abolish a commission, and it would not be surprising if the three commissions which have been the subject of this discussion should join with the Board of Arbitration, the Board of Riparian Commissioners, the three Oyster Commissions and the Bureau of Shell Fisheries to resist the

consolidations and the single-headed commissions recommended by Governor Fort.

Both New York and Pennsylvania have recently given their health departments thorough reorganization, vesting in each wide powers of control over water supply and sewerage. Massachusetts we have seen, and Ohio, it may be added, have given like control of water supply and sewerage to their state boards of health. Eventually, and it is to be hoped at once, New Jersey will fall into the ranks of progress.

LETTERS TO THE EDITOR.

"Capt. Pearson" Again.

Sir: Your issue of Jan. 16 contained a note from Prof. Edgar Marburg, warning the profession against an impostor, "Capt. Pearson, of the British Army." This same man told similar stories in New Orleans two years ago, was imprisoned here 20 days, and identified as a crook with a past record of penal service in England and America.

Very truly,
Owen M. Jones.

New Orleans, La., Jan. 19, 1908.

Poor Concrete Made with Dry Stone.

Sir: Some time ago a piece of concrete work was being constructed, in which it was found (when the forms were removed) that the concrete had not set. The cement was "dead" and the stone could be picked out of the concrete. In fact, some of the walls fell down. I was called to put the material under test, and found the cement good and sound. The limestone and sand were also good.

I made a block of concrete from the materials that had been used and left it in the laboratory. After 24 hours I could break up the block with my hands. The cement was "dead" and would not hold the stones, which could be pulled out. I then made another block with similar materials, but not taken from the work. This concrete set well and became hard. Investigation showed that the stone and sand had been out in the hot sun for several weeks (when there was no rain), and became so dry that when mixed with the cement to form concrete they absorbed the water and left the cement "dead" or inert. The piles of sand and stone were then wetted down with a hose, and concrete then made with these materials and the same cement proved to be of good quality.

E. A. Mollan,
Manager, Chicago Testing and Inspection Bureau.

Omaha Building, Chicago, Jan. 14, 1908.

Ice Consumption and Negroes in the South.

Sir: Your editorial note of Jan. 16, 1908, upon the ice consumption of the South, and other related matters, takes no account of the negro population. All statistics relating to the South, and discussions of conditions here, err in this respect.

The population of the cities of the far South is all of 50% African, and in some of them the percentage is even larger than this. Now, negroes consume little or no ice and milk, and statistics, to be correct, should place the consumption of these commodities almost exclusively among the whites.

As an example of statistical unfairness to the South, I beg to submit the following, though it bears no technical relation whatsoever to the subject of your editorial:

Divorce among the whites of the South is relatively rare, while, on the contrary, the negroes keep the divorce courts working overtime, and, even then, large numbers of them do not trouble the courts with their marital affairs when they desire a change of partners, just as many of them do not call for the services of church or state when entering into the partnership.

The U. S. Census statistics of divorce do not differentiate the whites and negroes, with the result that the South gets the credit for being the most immoral section of the country in the matter of divorce, and those unfamiliar with conditions here unthinkingly charge up the sins of the negroes against the whites.

The prevalence of typhoid and other intestinal diseases in the South can generally be traced to the filthy and unsanitary habits of the negroes. The one and only argument for right living and the observance of the simplest sanitary laws that they can understand, is the argument of the "big stick."

A Sufferer from the Negroes' Habits.

Montgomery, Ala., Jan. 20, 1908.

Coal Dust Explosions Again.

Sir: I beg to refer again to Mr. Dixon's report on "Dust Explosions in American Coal Mines," in your issue of Jan. 2, and quote therefrom as follows:

The introduction of electric coal-cutting machinery has intensified the danger, for it supplies the ammunition in large quantities and furnishes the spark to complete the operation.

From this one would naturally infer that an electric spark would ignite coal dust. The report as a whole would lead one to believe that most explosions are dust explosions.

The tests conducted at Woolwich in 1897-1900, doubtless the tests to which you refer, showed that every explosive on the "permitted list" had at some time or other caused an explosion of gas if fired without stemming. But very few of the explosives ignited coal dust. None ignited the dust but not the gas. Dust raised by a charge of gunpowder invariably ignited, which seems to indicate that a considerable quantity of heat must be present to ignite coal dust. Tests made at Frameries showed that certain high explosives which give off incompletely burned gases in exploding may under proper conditions cause an ignition of coal dust, indicating again that a considerable amount of heat is essential.

In regard to any combustible dust floating in a confined space, is it not reasonable to believe that the first essential to an explosion, provided the dust be present in large quantities, is sufficient heat to bring the dust particles to the kindling temperature?

Very truly, "Bituminous."

Republic, Pa., Jan. 20, 1908.

[We refer our correspondent and any others interested to Engineering News of Oct. 16 and Oct. 23, 1886, in which was reprinted the sections of the report of the British Commission on Accidents in Mines relating to dust explosions. A very great number of experiments on the explosive action of dust were described in that report.—Ed.]

The Effect of Steam Pressure on Economy.

Sir: In your reply to a correspondent in the Jan. 16 issue of your esteemed journal you say:

The water in a steam boiler at 5-lb. pressure is at a temperature of 228°. In a boiler at 150 lbs. pressure it is 366°, or 138° hotter. With very slow passage of the gases over the heating surface, as in a house-heating boiler for example, there should be a considerable difference of temperature in the gases going up the chimney and consequent better efficiency of the low-pressure boiler. In a feed-water heater or economizer utilizing the heat from the flue gases, the advantage of the low pressure will be much more marked. The rate of heat transmission is in general proportional to the total difference of temperature. With furnace gases at 1,500° this total difference will be 1,272° for the low-pressure boiler and 1,134° for the high-pressure boiler. In an economizer using gases at an average temperature of 500° this temperature difference will be 272° with 5 lbs. pressure inside the economizer and only 134° with 150 lbs. pressure inside.

Your statement of the case seems apt to give rise to serious misapprehension. The temperature of the water in the economizer is not that of the boiler, in fact, with the amount of economizer surface usually installed it never reaches the temperature of the boiler; it is rather determined by the temperature of the feed-water as it enters the economizer, the extent of the economizer surface and the temperature and quantity of the boiler flue gases. So, just opposite to your statement, *the economizer is more advantageous with a high pressure boiler* than with a low pressure boiler.

The reason is that the higher the pressure and, therefore, the higher the temperature carried in the boiler, the hotter will be the flue gases, other conditions remaining the same, since in no case can the boiler cool the flue gases below the temperature of its contents, and the higher the boiler temperature, the more heat there will be left in the flue gases to be taken up by the economizer. Moreover, the higher the boiler pressure, the greater is the range of possible usefulness of the economizer, since the greater will be the proportion of the heat required to make a pound of steam that the economizer can recover for the feed without actually making steam.

Yours very truly,
Geo. H. Gibson.

Tribune Building, New York City, Jan. 18, 1908.

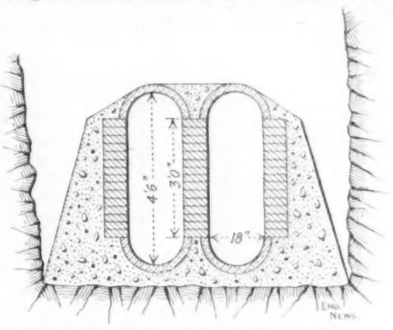
[Our statement was open to the misconstruction which our correspondent points out above, and we are pleased to give space to his explanation.—Ed.]

A Concrete Pipe Culvert in Santo Domingo.

Sir: I send a sketch and short description of a double culvert constructed by me at Moca, Santo Domingo. The railway from Santiago to Moca is about 20 miles long and is not a difficult piece of construction (or would not be in the United States.) There are seven bridges of from 50 ft. to 75 ft. span (plate girders), and many large culverts. All of the culverts and bridge abutments have been built of concrete.

For pipe culverts, I manufactured cement pipe 18 in. in diameter, 3 ft. long and 3½ in. thick, using Portland cement and bank gravel. In all I made some 4,000 ft.

In transportation from the United States the breakage of vitrified pipe is from 50% to 75% on account of the many handlings and the crude manner of transportation after they arrive in this country, so that the manufacture of these cement pipes made a great saving. It is almost impossible to have proper centering made in this country, due to poor mechanics and scarcity of suitable lumber. I therefore decided to make 18-in. pipe in two parts, using one-half for invert and the other half for the arch. The side walls were built of brick. These native brick are of very poor quality and to strengthen them I soaked them in Portland cement



Concrete Pipe Culvert, Built in Santo Domingo.

grout. They were only used as side lining and were built up first, taking the place of lagging, the concrete being placed against it. This culvert is located between very high and steep banks some 35 ft. below grade and is about 100 ft. long. The retaining walls at each end were laid in concrete against a brick facing, the brick being treated as in side lining.

Very respectfully,
Geo. M. Cushing,
Supt. of Construction,
Ferrocarril de Moca a Santiago.

Santiago de Caballeros, Santo Domingo, Dec. 5, 1907.

[The above is an excellent illustration of the way a resourceful engineer adopts means to ends in carrying out work under difficulties.—Ed.]

Diagrams for Reactions of a Continuous Beam of Two Equal Spans.

Sir: The accompanying diagrams have been constructed for the purpose of showing the reactions at the supports of a continuous prismatic beam of two spans under the conditions most commonly met with in engineering practice.

The conditions relating to the beam are that it shall be continuous over three level supports; that its two spans be of equal length, and that it be of constant cross-section.

Fig. 1 shows the case of a uniformly distributed load, the beam overhanging its end supports symmetrically. The curve for R_1 and R_2 was calculated from the formula

$$R_1 \simeq \frac{l'w}{8}(6\,r^2 + 8\,r + 3),$$

which was derived from the Theorem of Three Moments.

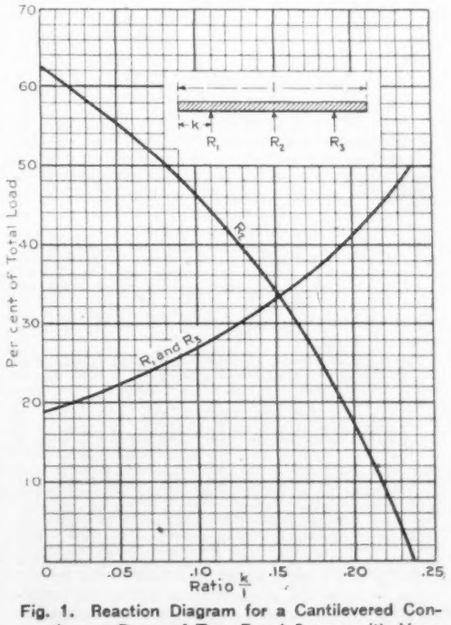


Fig. 1. Reaction Diagram for a Cantilevered Continuous Beam of Two Equal Spans, with Varying Lengths of Overhang, Under Uniform Load.

In this formula w is the load per unit of length of beam, l is the length of one of the two equal spans, and r is the ratio of length of overhang to l. By reading the curves at the value $\frac{k}{l} = 0$ we have the more common case of a beam without overhang, when $R_2 = \frac{5}{8}$ of the total load, and $R_1 = R_3 = \frac{3}{16}$ of the total load. As shown by the key figure, $\frac{k}{l}$ is the ratio of length of overhang to total length of beam.

The effect of a single concentrated load is shown in Fig. 2. The abscissa $\frac{k}{l}$ is now the ratio of the distance of the load from the end of the beam to the length of one of the two equal spans. The weight of the beam itself is not here considered, as its effect would be obtainable from Fig. 1. A single concentrated load placed between R_1 and R_2 tends to cause the beam to rise from its support R_2, the measure of this negative reaction being shown by the curve marked R_2. Of course a sufficient load (furnished by the weight of the beam itself or by other means) must be placed at R_2 to counterbalance this tendency, otherwise the condition of three level supports is not fulfilled, and the values of R_1 and R_2 will not be as shown by the curves. In Fig. 2

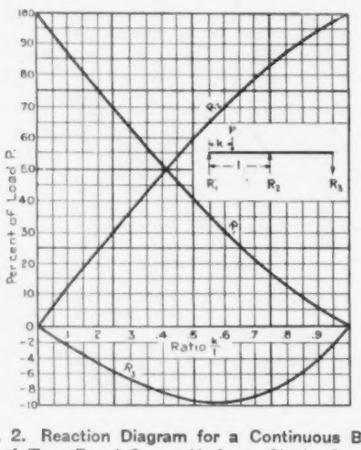


Fig. 2. Reaction Diagram for a Continuous Beam of Two Equal Spans Under a Single Concentrated Load.

$$R_1 = \frac{P}{4}(4 - 5k + k^3)$$

and

$$R_2 = -\frac{P}{4}(k - k^3),$$

from Merriman's "Mechanics of Materials." To apply Fig. 2 to the case of two symmetrical loads, it is only necessary to add the values R_1 and R_3, when half the result will represent the ratio of the end reaction to the sum of the two loads.

Yours very truly,

Frank T Daniels.

31 Milk St., Boston, Dec. 30, 1907.

Notes and Queries.

In the article on p. 75 of our issue of Jan. 16th, regarding the preservation of steel embedded in concrete, the concrete was a 1 : 3 : 5 mixture of cement, Cow Bay sand and washed gravel, laid under ordinary working conditions.

"Several," Culiacan, Mexico, writes:

Please give us some information regarding the "Southern Cross." What is its position in the heavens and at what latitude can it be seen and observations made on it for true meridian? Also, what does the constellation look like?

The constellation is described as follows in the "Century Dictionary":

The Southern Cross, the most celebrated constellation of the southern heavens, was erected into a constellation by Royer in 1679, but was often spoken of as a cross before; there even seems to be an obscure allusion to it in Dante. It is situated south of the western part of Centaurus, east of the keel of Argus. It is a small constellation of four chief stars, arranged in the form of a cross. Its brightest star, the southernmost, is of about the first magnitude; the eastern, half a magnitude fainter; the northern, of about the second magnitude; and the western, of the third magnitude and faint. The constellation owes its striking effect to its compression, for it subtends only about 6° from north to south and still less from east to west. It looks more like a kite than a cross. All four stars are white except the northernmost, which is of a clear orange-color. It contains a fifth star of the fourth magnitude, which is very red.

The brightest star, α Crucis, a star of the first magnitude, has a southern declination of about 62° 30'. The constellation is therefore entirely above the horizon at, say, 28° north latitude, and should be visible at Culiacan (lat. 25°). The right ascension of α Crucis is about 180°, so that the Southern Cross should be on the meridian at midnight in the latter part of March. For determinations of azimuth see Comstock's "Field Astronomy for Engineers" or Hayford's "Textbook of Geodetic Astronomy."

CONVENTION OF THE NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.

The first convention of this society, which was organized about a year ago, was held at Chicago, Jan. 23, 24 and 25. The purpose of the association is to encourage the establishment of trade schools for training boys and girls for future work in manufacturing and industrial occupations. Large numbers of boys who have no great taste for ordinary education leave school at about 14 years of age, and then drift into various haphazard occupations before they reach the age of 16 at which they can be employed by manufacturers. One speaker pointed out the great development of technical education in Germany, and remarked that in Berlin 55% of the boys between 14 and 16 years of age are in the industrial schools, training themselves and being trained as future craftsmen. In Chicago, less than 0.1% are getting similar training.

Public meetings were held at Fullerton Hall, and a number of addresses were made at a luncheon given by the Chicago Association of Commerce and at a dinner held at the Auditorium Hotel. These latter functions were specially designed in order to put the matter before business men, manufacturers and others who should be interested in the movement for the development of skilled workmen and foremen. The subject was treated from a sociological as well as from an industrial and technical standpoint.

In one of the addresses the following remarks were made by Prof. Charles R. Richards (of Columbia University), the Secretary of the association:

The prejudice of organized labor against the trade-school idea is based on the fear that such schools will turn out a large number of half-trained workers, who will tend to flood the labor market and lower wages and the standard of living. From thorough and soundly organized trade schools, giving sufficient time to the training of the workmen, organized labor has nothing to fear and much to gain. Any school giving a broad and thorough training in the trades will turn out men whose influence will be toward raising the standard of wages and not lowering them.

City school systems at the present time have direct possibilities of approaching this problem through the organization of general industrial schools that will aim to reach the great masses of boys and girls between 14 and 16 years of age who now leave the elementary schools before graduation. In most cities of our country only about 15% of the children in the elementary schools remain to graduate. The problem of the exact nature of the ideal industrial school is before boards of education all over the country. A type of school that presents large opportunities in this connection is the developed manual-training high-school, established in many cities. This is really a technical high school, which recognizes a vocational purpose and which trains young men to become foremen, draftsmen, designers, inspectors and experts. In the cases of the technical high school and the evening trade school for those in the trades the provisions mean simply an advance upon our present practice through a further utilization of present resources. To develop the general or preparatory industrial school, which aims to give a more effective start to those entering the industries, is more of a problem. The present manual training equipments in the elementary school might be made a basis for such work, but these equipments would undoubtedly have to be much extended and sufficient time given to the work to make it of real vocational value.

Mr. T. W. Robinson, Vice-President of the Illinois Steel Co., declared that in Europe industrial education is making the old world new, while in this country there are obsolete methods and general indifference to industrial education on any systematic or organized basis. Similar remarks, and comparisons with Germany and Japan in particular, were made by Mr. James R. Van Cleave, President of the National Association of Manufacturers; and by Mr. Henry S. Pritchett, President of the Society. Dr. Charles W. Eliot, President of Harvard University, suggested that the children who are to enter the trade schools after the age of 14 should be to a large extent selected by the teachers in the elementary schools, who are in a position to judge of the capacity and ability of their pupils. He considered that with a system of trade schools in operation the age for compulsory education should be raised from 14 to 17 or 18 years. The trade schools should then be continuation schools for those who have been compelled to leave the regular schools at the age of 14.

One of the meetings was devoted to the subject of the apprenticeship system as a means of promoting industrial efficiency. This referred mainly to the systems adopted in some large establishments, as apprenticeship to a trade instead of to an employer has practically disappeared in this country. The apprenticeship and scholarship system of the International Typographical Union was, however, described by Mr. W. B. Prescott, Past President of that Union, in a paper on "The Value of a Thorough Apprenticeship to the Wage Earner."

Among other things, he considered that employers must change their attitude toward the workmen. For instance, it is most unjust that a man should be fined or be discharged for loss of time in the case of sickness or accident in his family. He cited cases where this had been done, and thought they represented the average attitude of the employer to the employee who is a "workingman" or engaged in manual labor.

Mr. W. R. Warner, of the Warner & Swasey Co., dealt with "The Apprenticeship System of To-Day," and Mr. J. F. Deems, General Superintendent of Motive Power of the New York Central Lines, spoke on "Trade Instruction in Large Establishments." He did not approve of night schools, but thought the instruction should be part of the regular shop work. It is not satisfactory to put apprentices in charge of the regular foreman, as he has little or no time to devote to their instruction, even if he has the ability to instruct, which is not always the case. The shop instructor should be a man competent for the duties and giving his entire time to the work. This is the practice in the apprenticeship system adopted by the New York Central Lines, which system he outlined in a general way. It is in use at ten of the shops, where about 500 apprentices are being trained.

Mr. Otto M. Becker referred to the growth of engineering colleges, but pointed out that these are in the main for boys who can afford to pay their way, and not for boys of the "working classes." Furthermore, these colleges aim to produce engineers rather than expert workmen, while the trade schools are being advocated especially to produce skilled mechanics. Dr. Graham Taylor remarked that while many manufacturers are trying to introduce apprenticeships in their plants they do it for their own benefit rather than for that of the boy or the community, but in the organization of a trade school system the human element must be given larger consideration. Such a system must also be considered in its relation to trade organizations if practical results are to be obtained. Another speaker remarked that out of 400 firms to which he had written, only 60 had introduced apprenticeship in any way, and only three of these claimed to give really first-class instruction. Addresses were also made by the heads of some existing trade or industrial schools.

ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF CEMENT USERS.

The fourth annual convention of the National Association of Cement Users was held in Buffalo, N. Y., from Jan. 20 to 25, 1908. This society, founded in Indianapolis in 1904, was organized by men interested in the concrete business, to put on a firmer basis an industry the very success of which has resulted in so rapid a growth that attention to detail has often been lost sight of in the more remunerative practice of executing the work. The usual exchange of ideas and reading of papers has been supplemented by a gradually increasing exhibition where the latest appliances and developments of the mechanical side of the business are set forth in great detail and in large numbers.

Originally the association was largely com-

posed of small contractors in sidewalk and foundation work, with a heavy proportion of concrete block manufacturers. Now, however, the engineers and contractors who employ concrete on large works are beginning to interest themselves in the society, though it must be said that they are still largely in the minority.

Before the association can hope to exert a great influence upon the larger users of concrete it must enlist the cooperation of more of the concrete engineers, architects and contractors who are making important structures of concrete.

Concrete sidewalks, foundations, walls and other elemental forms are accepted constructions and their development can be of but routine importance. Concrete blocks, as they have been exploited, have done more harm to the progress of concrete among men who could advance its general use than all the attacks of the advocates of other structural material. The better element in the society is arrayed against a certain class of cheap concrete block manufacturers, and in this opposition should have the help of engineers and architects. The concrete block is an admirable building material, but it has been too much exploited by shortsighted men who care nothing for the appearance or strength of the product they turn out.

The present convention did much to advance the interests of the industry.

The papers presented related principally to practical details in concrete construction and many of them were of a high order of merit, although in view of the character of the attendance, many of the papers were elementary in their treatment. There were seven regular sessions of the convention devoted to these papers and discussions in addition to several sessions in which certain specifications were thoroughly discussed and revised previous to being accepted by the convention as a whole in general session. About 300 active members were in attendance in addition to as many more exhibitors and attendants at the show.

Mr. Richard L. Humphrey, of Philadelphia, president of the association, opened the convention with his annual address, a portion of which is reprinted below.

PRESIDENT'S ADDRESS.

The frenzied efforts made to use cement in constructive work without adequate knowledge of proper structural methods, has resulted in much harm, but, fortunately, there has been a turn towards conservatism, which has effectually checked this tendency. Probably the greatest obstacle will be removed when the discriminating and antiquated municipal laws which exist in so many of the large cities of this country, with their unjust and absurd limitations concerning the use of concrete, have been replaced by rigid but just revisions based on our present knowledge. The cause of concrete will be materially benefited by the adoption of laws that will prevent criminal construction by irresponsible parties.

One of the greatest handicaps in the development of the use of cement for constructive purposes has been in the wide dissemination of claims by overzealous enthusiasts that concrete structures can be erected by unskilled laborers. This fallacy is being rapidly removed and the friends of concrete would do well to emphasize the fact that like any other building material, it must be carefully and intelligently handled in order to produce the best results.

The creation of the office of Inspector of Concrete by municipalities for the purpose of enforcing the building laws is another hopeful sign and marks the best progress that has been made during the year. It should not be forgotten that the existence of these inspectors, whose tenure of office is dependent on political conditions, can be of no great service except insofar as it serves as a constant reminder of the care that should be exercised in building construction.

The continued use of materials which have been shown to be inferior in the construction of so-called "fireproof" buildings in our large cities, and the continuous discrimination against materials known to possess superior qualities, is a matter of constant wonder.

There is a fallacy which is quite prevalent and which should be removed, and that is the feeling that concrete in itself a fireproof material, requires no protection against fire when used as a structural material. The same protective coating of concrete should be applied in the case of a structure of concrete as would be required in case of a similar structure of steel.

Concrete, by reason of being a comparatively new material, especially as far as its application for structural purposes is concerned, receives greater attention than all the other building materials, and it is not surprising, therefore, that any damage which occurs in the construction of such a structure should gain the widest publicity, while structures of other materials which collapse rarely receive passing attention.

We cannot emphasize too strongly the fact that it is only during construction that concrete collapses occur and that such collapses are almost invariably occasioned by improper design, workmanship or materials. Concrete structures once completed do not collapse but stand as monuments of durability, strength and economy.

REINFORCED CONCRETE.

In the discussion of the use of reinforced concrete in large construction, particularly in buildings of some size, there were two main divisions in the papers. The first advocated the use of separately molded members cast in a factory or on the ground near the place of erection and put in place as units, tied together by some mechanical bond. The second favored monolithic construction, and more particularly that kind of monolithic construction in which continuity of reinforcement is assured.

Previous to these papers Prof. W. K. Hatt, of Purdue University, delivered a lecture on the "Elementary Mechanics of Reinforced Concrete," a discussion calculated to instruct those not acquainted with this style of construction in the theories of its design. He used the methods now in force in his university classes in the teaching of the subject to beginners, first showing drawings of a typical beam and photographs of its manufacture and testing, passing therefrom into the simplest methods of computing according to the generally accepted straight line theory.

FACTORY-MADE CONCRETE.—Mr. Charles D. Watson, of Pittsburg, in a paper called "Factory-Made Concrete" explained the system now being developed by his own company, in which beams, girders, columns and slabs are cast in a shop especially designed for such purposes, to be afterwards kept in stock and sold to customers for shipment to any desired place. On account of the excessive cost of forms for field erection and the unreliability of field-made concrete, he claimed that the time has come when some other method of building reinforced concrete must be devised. With his system the multiple use of forms and the ease with which they can be manipulated renders the costs for that item low and as great exactness of proportioning and uniformity of mixing is possible, the two difficulties of the other system are overcome.

The advantages of the factory-made material according to Mr. Watson are: the elimination of forms, concrete of much greater strength, the use of more economical sections, the economy of shop methods of handling and mixing the materials, the greater speed of erection, certainty of results on account of mechanical methods of fabrication, the opportunity to test before subjection to the load, the ease of alterations, the absence of accidents during erection and the high grade finish made possible by better forms.

The two great objections to the system are the cost of transportation of the finished members and the lack of continuity at connections. In regard to the first it is claimed that the reduction in cost of fabrication much more than makes up for the extra cost of transportation. The second disadvantage is more serious and the detail on which the most study must be made in the future. A proper recognition of the necessity for continuity requires that the steel shall be so arranged as to make bolting of one member to its neighbor a mere mechanical detail.

Mr. W. H. Mason, Stewartsville, N. J., described, with illustrations, the factory built according to a similar unit system by the Edison Portland Cement Co. at Stewartsville. This construction was quite fully treated in Engineering News for July 4, 1907, p. 5.

CONTINUITY IN STEEL REINFORCEMENT.—In contradistinction to the separate-member system, Mr. E. P. Goodrich, New York, read a paper on "The Necessity of Continuity in the Steel Reinforcement of Concrete Structures." He stated that if a monolithic construction is deemed best, it becomes necessary to arrange the reinforcement so as to ensure absolute continuity in the various members.

When first designed, concrete structures were made similar to the then existing styles of construction in which each member was a unit attached to the adjoining one in such a manner that it could move slightly under any of the secondary stresses to which it was subjected. In the progress of the industry this method seemed not to be so well adapted to concrete as a monolithic system in which, within given limits of size, all the members are tied firmly together by steel reinforcement. This reinforcement consists of all metal used to tie members together, such as the pin connection between girder frames and wiring between slab and beam rods. In addition steel must be added to take up secondary stresses due to temperature, shrinkage and vibration, and finally to care for the reversed stresses from continuous action in beams, such stresses as the rods in the upper flanges of a beam near its supports are provided for.

In conclusion Mr. Goodrich emphasized the fact that if a concrete building is to be made monolithic it must be made continuous in all its parts, for that portion that is left weak will be the first to be affected by the primary loads and secondary stresses, and unsightly cracks will appear. Occasionally he deemed it wise to provide expansion and contraction joints in buildings as is usually done in walls and bridges, but this is only advisable when the structure is so large that the steel necessary to prevent cracking is beyond the limits of economy.

UNIT VS. LOOSE-BAR REINFORCEMENT.—Mr. Emil G. Perrot, of Philadelphia, continued this discussion with a paper on "The Unit vs. the Loose-Bar System of Reinforced Concrete Construction," in which he strenuously advocated the unit system. In the loose-bar system, as ordinarily practiced, the reinforcement is designed out of separate bars or rods to be shipped as individual pieces to the job and there bent to the proper shape and wired together in place in the forms. Owing to the inability of inspectors and superintendents to be everywhere at once, and often to the incapacity of these men, these rods are in many cases incorrectly placed or left out altogether. As the amount and position of the steel in a section materially affects the strength of the member, such oversights reduce the factor of safety of the structure to a very low amount.

In the unit systems the reinforcement for each member is carefully manufactured either in a shop or on ground adjacent to the building and put into the forms as a unit, its shape and construction ensuring its position and integrity. In some of the newer systems these unit frames are provided with connections so that the adjacent reinforcements may be joined firmly together, thus providing the necessary continuity of the structure. This avoids the necessity of a large corps of inspectors and allows the use of unskilled labor in placing the steel.

Mr. H. H. Fox, New York, defended the loose-bar system and asserted that efficient inspection is provided by the larger and more competent contractors at lower cost than that which is required in the fabrication of the unit frames, with a resulting uniformity in the loose-bar construction equally as good as in the other. In addition the single rods are much more easily procured, thereby providing a much needed elasticity in the system.

REINFORCED CONCRETE AND THE CONTRACTORS.—Under the title "Reinforced Concrete from the Contractor's Point of View," Mr. H. H. Fox, New York, outlined many of the details of the contractor's side of reinforced-concrete construction. The paper appears elsewhere in this issue.

METAL FORMS.—Mr. W. L. Caldwell presented to the convention a model of a metal form recently devised by the Berger Mfg. Co., of Canton, O., to be used in concrete column, girder and slab construction, the whole system being a unit made of pressed steel. His paper brought out much discussion of the metal form in concrete work. The general impression seemed to be that owing to the increase in the price of lumber some such device is rapidly becoming

necessary to the growth of concrete, but that to date no available system had been invented.

The main trouble with those used in the past seems to be their liability of leakage, tendency to rust and the injury by dents in removing. These troubles Mr. Caldwell claims to have remedied and his model was examined with much interest.

MIXING AND PROPORTIONING CONCRETE.

In the mixing and proportioning of concrete so as to make the most efficient mixture, the following papers were read. Mr. L. C. Wason, Boston, Mass., in his paper upon "Proportions Used and Methods of Mixing Concrete," devoted his attention to the effect of proportions on the strength of concrete, which he said was of interest to the engineer and to concrete equipment, its methods and costs, which more especially concerns the contractor.

In comparing hand-mixed with machine-mixed concrete he said that in a series of tests he found that the latter produced concrete of a strength 25% greater than the former. Clean sand is always necessary; by clean sand meaning any which will not cloud for any considerable time water into which it has been placed. As between gravel and crushed stone there is little to choose except that it is easier to obtain dense concrete for watertight work with gravel, as crushed stone is liable to arch, causing voids.

In proportions of the mixture, Mr. Wason uses a 1:3:6 mix, which he claims to be amply strong for any structural work not subjected to extraordinary strains. In mixers, a batch mixer, more particularly a batch mixer of the cylindrical drum or double cone type, is recommended because it gives a more certain result than the continuous mixer.

WATERPROOFING CEMENT STRUCTURES.—Mr. James L. Davis, of the Board of Water Supply of New York City, made a report of the work done in that laboratory, a larger part of which has been published in his own and Mr. Gaines' papers before the American Society of Civil Engineers (Eng. News, Sept. 26, 1907, p. 345, and May 30, 1907, p. 599). A continuation of the experiments previously reported seem to show that a well mixed concrete with a properly proportioned aggregate and a correct percentage of colloidal clay or electrolyte will produce an impermeable concrete even under excessive heads of water. Mr. Davis said:

> The writer believes the greatest advancement is waterproofing for general purposes, such as the construction of basement floors, walls, conduits and dams, is to come through securing practically impervious mass concrete rather than by the use of surface washes or asphaltic coatings, useful as these may be in many cases. For resistance up to 50 ft. head of water, the art is sufficiently advanced so that the question is which of several processes is the cheapest, rather than is it practicable to build water-tight work in concrete.

In discussion it was brought out that many members had had success in waterproofing concrete blocks by the admixture of various of the patented waterproofing mixtures, though several stated that they had much trouble from a white efflorescence that appeared on blocks so treated.

ARCHITECTURE OF CONCRETE.

One whole evening had been set aside for the consideration of the artistic development of concrete construction, and four papers had been arranged for, but, unfortunately, two of the speakers could not be present. Mr. E. B. Green, an architect of Buffalo, read a paper on "Treatment of Concrete Surfaces" which, outside of some general architectural platitudes on mass, form, scale and voids, consisted principally of the report of the Committee on Applied Arts and Sciences of the American Institute of Architects, which admits the wonderful possibilities of this plastic material but does not make any specific recommendations as to style other than to note the so far undeveloped availability of concrete as a facia covering for steel structures.

Mr. Green's paper was disappointing to the same extent as have been all of the numerous papers read recently by architects on the same subject. The architect is an artist and an idealist, whose ideas as to correct forms of art are generally in a plane above the layman in both their conception and expression. It is probably impossible for him to state in as many words what he considers a proper architecture for concrete; rather does he spread long sentences about the disposition of mass and voids, the outward expression of an inner thought and such phrases as "monuments expressive of a highly temperamental force, breathing little or nothing of spirituality."

Architects have built artistic concrete buildings and will continue to improve in their design, and the engineer who, notwithstanding the views held by the architectural mind, is anxious that artistic concepts should hold in all construction, generally feels that a vast amount of nonsense is being talked about the architecture of concrete. There is a great void waiting to be filled by a clear, common sense paper on this subject by an experienced architect.

The second paper of the evening was by Mr. Albert Moyer, of New York, on "Exposed Selected Aggregates in Monolithic Concrete Construction." As an illustration of what can be done with concrete, Mr. Moyer described, with the aid of lantern slides, a residence recently erected in South Orange, N. J., in which the walls were built of a concrete made of carefully selected aggregates of a uniformly small size and variegated and brilliant color. In this construction the forms were removed the day after the laying of concrete and the entire exterior surface scrubbed with a brush and water until these small stone particles stood out well from the mortar matrix and the dirty face which usually flushes to the surface had been removed. This method of surface treatment is not original with Mr. Moyer, being identical with that in use for some time by Mr. H. H. Quimby on the bridges at Philadelphia and described very fully by him in a paper before this association at its last year's session (Eng. News, Dec. 20, 1906.) In its application to residences Mr. Moyer has, however, made one improvement, by the addition of artistically arranged multicolored tiles into the concrete while still wet, forming graceful designs now appearing as a part of the wall.

In this same connection Mr. Robert W. Lesley, Philadelphia, showed some views of the interior of the new Racquet Club in that city, in which the entire interior decoration is composed of rough concrete just as it comes from the forms, with the addition of inlaid parti-colored tiles. This new departure is particularly effective in interior decoration and in residence work; it is, of course, of no value in the more commercial utilization of the material.

The work of the government in cement and concrete was described by Mr. E. T. Perkins, of the U. S. Reclamation Service, who delivered an illustrated lecture upon the various work that service is doing in the immense irrigation projects in the arid west, and by President R. L. Humphrey, who gave a detailed and illustrated account of the various tests now being carried on by the Structural Materials Testing Laboratory at St. Louis, Mo., of which Mr. Humphrey is the director.

SPECIFICATIONS.

CONCRETE HOLLOW BLOCKS.—The Committee on Standard Specifications, Mr. E. S. Larned, chairman, presented Standard Specifications for Concrete Hollow Blocks, the larger part of which appeared in our issue of Jan. 23. There was considerable discussion of these specifications, but they were adopted as first designed with some minor changes. Copies of the specifications can be procured from the secretary of the association. They will be sent to the various municipalities with the hope that they will be adopted as standard.

CEMENT SIDEWALK.—The main discussion on these specifications was on the question of a sub-base. Most of the regulations now in force require a heavy foundation of from 6 to 18 ins. in which a layer of cinders, rock or hard tamped clay is filled. In the opinion of many of the members this is unnecessary, and much testimony was advanced showing that cement walk laid directly on an ordinary foundation is equally as serviceable as when a cinder or other bottom is employed. The portion of the specification requiring a sub-base was therefore omitted, leaving the question to the option of the owners of the sidewalk. This set of specifications will shortly be printed and distributed.

COMMITTEE REPORTS.

In the report of the Committee on Testing Cement and Cement Products, Mr. E. S. Larned, of Boston, read an extensive paper on some tests he had made on the value of various sands in concrete and presented tables showing the results of the tests.

The reports of the committees on Concrete Blocks and Cement Products, Machinery for Cement Users, Fireproofing and Insurance and Laws and Ordinances, were accepted as progress reports.

Mr. C. D. Watson, Pittsburg, Chairman of the Committee on Art and Architecture, reported that in the coming year it is intended to ask architects to submit to the Association designs of the concrete structures that they are building, and that a committee of architects will be asked to select from these designs those that best represent artistic concepts, the same to be published in the annual report of the association.

EXHIBITION.

The exhibition, held in the old 65th Regiment Armory, was far in advance both in size and interest to any held. Over 50,000 sq. ft. of space was occupied by 120 exhibitors. The larger part of the exhibits contained full size machines in operation or actual demonstrations of forms, reinforcing details, waterproofing, surface coats, etc. A greater portion of the sections were allotted to concrete blocks or block machines, many of which still showed peculiarly inartistic rock faced or decorated specimens, but the expressed dislike of such forms must surely have shown to the makers that any further increase in their business must come from more rational developments.

One night was set aside as "Buffalo night," and it is estimated that fully 10,000 persons visited the hall, giving the material a publicity that can but result in its wider use.

OFFICERS.

Practically the same officers were continued for another year. The President has served in that capacity since the organization of the society. The principal officers are Mr. Richard L. Humphrey, President, Mr. H. C. Turner, Treasurer, and Mr. George C. Wright, Rochester, N. Y., Secretary. During the meeting it was decided that the time was ripe for the appointment of a permanent secretary, on salary, so that he could devote all of his time to the business of the association. A committee was therefore appointed to collect subscriptions which should be used to pay the expenses of such an officer. It is understood that this movement is meeting with much success and that the appointment of a permanent secretary is assured.

REINFORCED CONCRETE FROM THE CONTRACTOR'S STANDPOINT.*

By H. H. FOX.†

To make the best possible reinforced concrete it is necessary:

1. That the forms should be strongly built, smoothly finished, as nearly as possible watertight, and left in place until the concrete is self-supporting.

2. That the reinforcement should be designed to relieve the concrete of all stresses which concrete cannot safely withstand, and to be amply protected from fire and weather by concrete on all sides; that the reinforcement should be so securely fixed in place before concreting that the concreting will not disturb it.

3. That the concrete should be mixed and placed in such a way that the final production will be homogeneous and without voids.

First.—Forms should be built of matched and dressed lumber and should be greased to make them part easily from the concrete. The length of time which should be allowed to elapse before removing forms depends upon

*Paper read before the Fourth Annual Convention of the National Association of Cement Users, Buffalo, N. Y., Jan. 24, 1908.

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two factors—the weather, and the load to which the member in question will be subjected upon removal of the forms. The fact that the concrete sets more rapidly the warmer the weather needs no elaboration. It is, however, never out of place to utter a warning against taking risks with concrete in cold weather. Scratching concrete with a knife gives one a rough idea of its strength providing one scratches often enough to become thoroughly familiar with the behavior of concrete under the knife. In general the nearer the load to be sustained approaches the load for which the member was designed, the longer the forms must remain. Thus the forms for an overhanging cornice should remain in place longer than the forms for almost any other member, because the dead weight of the cornice is a very large percentage of the total weight which it is designed to carry. By similar reasoning, roof forms should remain longer than floor forms, floor forms longer than column forms, column forms in the top story of a building longer than column forms in a lower story, and column forms in general longer than footing forms.

It is very important that forms should be so designed that the column forms may be removed without in any way disturbing the supports of the beams and girders bearing on these columns. In this way a defect in a column may be detected and remedied before any load is brought to bear upon the column. In removing beam and girder forms, the posts should be removed from only one beam or girder at a time, and as soon as the form for this beam or girder is removed, the posts should be immediately replaced. By this procedure, danger of failure of concrete through poor workmanship is much diminished, as a defective member is supported by the members on either side of it until the defect may be remedied. The practice of removing all the posts under a floor at the end of a given period—one, two, or three weeks—without pausing to remove the forms one at a time, examine the workmanship, and replace the posts, cannot be too strongly condemned; both because of the possibility of defective workmanship, and because the concrete floor, even if not defective, may not be strong enough to carry in addition to its own weight, the weight of the one or two floors which may, by the time the forms are removed, have been constructed above it.

There is less danger in taking down column forms when the concrete is 36 hours old, and floor forms when the concrete is five days old, if the posts of each member are removed separately, and as soon as possible replaced, than there is in knocking out all the posts under a large piece of floor in three weeks. Legislators who frame laws aiming at safety in concrete construction should bear this in mind.

It is of the first importance that the foreman in charge of removing forms should be of a high order of intelligence, and a man who can be relied upon to obey orders literally, for the reason that a mistake on his part is more likely to cause damage to life and property than a mistake on the part of any other foreman.

Stirrups should touch the forms only in two points and be therefore, well protected against fire. The stirrups should not be relied upon to support the tension bars in place, but hangers should be used. As these hangers are of no further value after the concrete is in place, the fact that they are supported directly on the forms, and are thus not fireproofed is of no importance. The middle portion of tension bars in beams and girders is thus held in place by hangers; the ends are held in place by being laced with wire to one another and to the vertical reinforcement in the columns. The bars in the floor slab are supported off the forms as follows: In order to obtain continuous action over beams every alternate tension bar in the floor slab is sprung up where it crosses a beam, being supported at the edge of each beam by a short piece of band iron about 1½ ins. narrower than the thickness of the floor slab, and bent to an angle of about 60°, so that it will stand on edge by itself. In the middle of each span a bar runs at right angles to the tension bars, on top of the tension bars, and is held at any desired distance above the floor by staples into the floor cover and by the lifting tendency of the tension bars which are sprung up over the beams. The other tension bars are then raised from the floor by lacing them with wire to this central bar.

To insure fireproofing in columns, four sticks are used in tamping the concrete columns, and these sticks are run down one on each side of the column between the hoop or spiral reinforcement and the form, thus insuring an amount of fireproofing equal at least to the thickness of the stick. The vertical reinforcement is placed inside the hoop or spiral reinforcement.

How to mix concrete well, by hand or by machine, needs no discussion. How to place it well is another matter. In the case of floors the trick is simple. Concrete should not, unless it is absolutely necessary, be dumped from a wheelbarrow directly against the form, but should be dumped on the soft concrete already in place. The mortar, flowing more freely than the stone, keeps always ahead of the mass, and stones falling in this mortar find a perfect bed; whereas if a barrowful of concrete is dumped into a dry beam the stones may become jammed between the forms and the steel and form a pocket into which the mortar will not enter. A few years ago I visited a very large concrete job on which the old-fashioned specifications were in force—that concrete must be placed in thin layers. Nobody on the job seemed to know the trick of placing concrete properly; and consequently the contractor, in order to obtain smooth workmanship, was placing an inch or two of clear mortar in the bottom of all beams and girders before filling them with concrete. The expense entailed by this may be imagined. The place to dump the first barrowful of concrete when starting a piece of floor, is either on the floor slab or in a column.

In concreting columns it is necessary to proceed slowly at the bottom of the column and to tamp the first foot with great care. After the mortar flushes to the surface over the entire section of the column, there is little danger of voids being left in the part of the column above the first foot if a sufficiently wet mixture is used. Walls should be similarly handled.

An exterior column is usually made square for architectural reasons. An interior column is octagonal, partly for architectural reasons, partly to save concrete. This saving is due to the fact that in a column reinforced with a spiral, the concrete outside the spiral is not figured as adding compressive strength to the column; and therefore, if this column is square, the concrete in its four corners is wasted. Of course, the question arises whether the concrete saved pays for the additional carpenter work. As a rule, the two items almost counterbalance each other, so that the matter of appearance is more important than the matter of economy.

Two sides of the columns are held together by bolts; the two opposite sides, by hardwood wedges between the bolt and the form as close as possible to the end of the bolt. In some cases the sides are made up of narrow strips. This is to facilitate the reduction in size of the columns from floor to floor. In warm weather there is no need of having more column forms than one complete set for one story, even when work is progressing at the rate of a story in five or six days. In a ten-story building each column form is then used ten times, once in each story. Each of these narrow strips represents the reduction in diameter of the column from one story to the next. It is, of course, much cheaper to have these strips ripped beforehand in the mill than to have a carpenter rip off a strip for each successive story. The outside and inside of the exterior column form are not made up of narrow strips for the reason that exterior columns are usually the same width from basement to roof. To reduce the section of an exterior column, only the thickness is reduced.

In removing forms the column forms are first removed. As has been said, the details about the tops of column forms should be so designed that they may be removed without in any way disturbing the beam and girder forms. Next, the posts are taken from under the girder. The girder bottom then drops and the posts are immediately replaced. The nails are drawn from the key, which is nailed only to the girder side; the key is knocked out, the posts are taken from under the beam, the so-called "spreaders" are knocked from under the cover, and the beam form comes down in one piece. The girder sides, which are bevelled at the ends, come out easily as does also the cover, which is bevelled on all four edges.

A circular saw will effect economy in a building of moderate size, especially if the same engine or motor may be used to run the saw and other machines, such as a boring machine, a steel hoist, or a grindstone.

In warm weather, with a complete set of forms for one story, a speed of construction of one story in eight or nine working days may be attained. With one complete set of column forms and a set and a half of floor forms, a speed of a story a week may be attained. The size of the building in plan makes very little difference.

In the discussion of methods of handling steel, the first question is, to what extent shall machinery be used in bending bars. At the present day there is, so far as I know, no machine which bends tension bars for beams and girders as economically as they can be bent by hand. For one thing, the cost of handling the bars to and from the place of bending is a very large percentage of the cost of bending, and this cost would remain the same in either case. The decisive reason is, however, that the variety of possible shapes of bent bars is infinite; the number of different shapes required in one building is very large, and a machine to be efficient would have to be capable of rapid adjustment from one shape to another, and consequently complicated.

In making spirals two processes are involved: First, bending the steel, which is usually in the form of wire, to the required diameter; second, spacing the coils to the required pitch, and fastening them so rigidly to longitudinal bars that this pitch will not be disturbed in handling. The first process is accomplished more economically by machine, the second usually by hand.

A simple cast iron block for bending beam and girder bars may be made of a block of metal with a longitudinal groove cut in it. The block is attached rigidly in a horizontal position to a bench, the bar is dropped in the slot, a piece of extra heavy pipe is slipped over the end of the bar, and two or three men bend it to the required angle. This bending block may be made of an iron plate with two angles riveted to it back to back to form the slot. Stirrups when bent by hand are bent on such a plate, the angles of course being small and only far enough apart to admit a bar of the size used for stirrups. A plate for bending stirrups may be made small enough to slip into the pocket.

Spirals are made up on a simple wooden reel, the requisites of this reel being that it should be rigid, adjustable for different diameters, and collapsible to allow the finished spiral to be easily slipped off.

The question whether power other than hand-power should be used to hoist the reinforcement to the floor where it is to be used, depends upon the height of the building, the quantity of steel on each floor, the rate of progress and the prevailing rate of engineers' wages. In New York City the wages of an engineer for one day will pay for a good deal of hoisting by hand, and it may be roughly stated that when the rate of hoisting is less than one foot-ton per minute, nothing is gained by installing special machinery for hoisting steel. It is of course necessary to have steel on a floor before concrete; therefore, the necessity of having a derrick light enough to be attached to the forms before they are filled is apparent. The strain of the fall-rope on the derrick pulls the column out of plumb less than an inch, and this displacement is easily recovered with a guy-rope and turn-buckle before concreting.

The question whether or not a charging hopper shall be used depends on several things. Unless it is possible to set the mixer several feet lower than the storage of sand and stone, some kind of hoist must be arranged to fill the hopper. This means additional machinery and generally the wages of an additional engineer. In New York City one of the obstacles to setting a mixer much lower than the storage piles is tidewater. Basement floors in New York are often laid as near tide level as possible; during the construction of a building the basement is used for storage of sand and stone and in order to set the mixer much lower than the basement floor an expensive waterproof pit must be constructed. A charging hopper of course makes it possible to charge the mixer more rapidly than the concrete can be taken away, up on the floor. The mixer should be set so low that the wheelbarrows run on a level grade or slightly down-grade in feeding the mixer.

The question how large a mixer to instal depends upon the rate at which concrete is to be used. Without a charging hopper an ordinary mixing plant will turn out easily 40 batches per hour, and may be made to turn out 60 batches if the hoist is designed to take it away as fast as that. In laying out a schedule for concreting, attention should be given to the fact that speed makes for economy, for the reason that there are several special men in a concrete gang whose wages remain the same regardless of the amount of concrete placed. These are an engineer, a foreman, and at least three laborers, namely, one throwing water into the mixer, one dumping the mixer, and one loading the wheelbarrows up on the floor. The sum of their wages at New York rates is $16.60 per day. If 80 cu. yds. are mixed in a day these men add to the cost of mixing about 20 cts. per cu. yd.; if 160 cu. yds. are mixed they add only 10 cts. per cu. yd.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The first session of the 14th annual meeting of the American Society of Heating and Ventilating Engineers was held in the afternoon of Tuesday, Jan. 21, at the Engineering Societies' building, West 39th St., New York City. This was a purely business session, at which the usual reports were presented.

The first professional session was held Tuesday evening, when a report was presented by the Committee on Fan-Blast Heating. This committee was appointed in 1907 to codify and analyze such data as could be secured. The committee decided at the outset that the field was so large that it would confine its attention to hot-blast heaters. Lists of questions and requests were prepared and submitted to the principal manufacturers of this apparatus and to members whose practice was known to include this class of work. These questions were designed to show the general schemes of design, construction and operation. However, the replies were so insufficient in number and so incomplete in detail that definite conclusions and classifications were impossible. The discussion of this report was in the nature of a hair-splitting analysis by three or four members, of a few of the replies, lasting until late in the evening.

"The Transmission of Heat Through Radiator Surfaces at Various Temperatures" was the title of a paper by Prof. John R. Allen, University of

Michigan, that was presented at the second day's session, in very brief abstract. The results of experiments were shown in which it was definitely determined that the rate of transmission was not constant, but varied with the square of the temperature difference between steam inside and air outside the radiator. It was stated that the heat units radiated per hr. per sq. ft. varied from 1.67 to 2.27, the latter figure being for 240° temperature difference. The following two formulas were presented for obtaining the value of this factor:

$$C = 0.0036\ (t_1 - t_2) + 1.32$$
(for two-column radiator.)
$$C = 0.0047\ (t_1 - t_2) + 1.14$$
(for three-column radiator.)

At this second day's session a report was presented from a committee appointed to secure data on hot-water heating. This report was a compendium of current practice in figuring the radiation losses through parts of buildings, in computing the amount of radiating surface necessary for direct and indirect systems and in selecting proper sizes of pipes for mains, risers and branches. The discussion on this paper, although quite lengthy and at times heated, turned on protests from some members that they were unable to obtain the grate area and heating surface of such boilers. This condition was denied in some cases and explained in others by the misuse and mis-interpretation of such data when published. As a result of the discussion the meeting requested the appointment of a committee to continue the investigation of the hot-water heating boilers.

A paper, scheduled among the topics for discussion at this session, but deferred until later on account of lack of time, was a translation, by W. W. Macon, editor of "The Metal Worker," New York City, of the "Austrian Coefficients for the Transmission of Heat Through Building Materials." These figures were published by the Society of Austrian Engineers and Architects, and are supposed to be based on tests of the heating and ventilation of the new stock exchange at Budapest. In general the coefficients were much higher than what are regarded as high values in America, which fact is somewhat surprising in view of the general impression that the foreign buildings are more carefully built than the American and have less leakage about openings. These figures when compared with the committee report on hot-water heating mentioned before, show 30% to 50% increase over conservative American practice for walls, 10% to 50% increase for openings, etc. The refinement to which the Austrian engineers have worked is shown by the presence of different values for all thicknesses of brick and concrete walls of eight different forms of construction, all kinds and thicknesses of interior partitions, floors and roofings, windows and doors.

"The Relative Corrosion of Wrought-Iron and Soft Steel Pipes" was the title of a paper by Mr. T. N. Thomson, International Correspondence Schools, Scranton, Pa. This formed the principal topic of the third day's discussions and recounted attempts to determine by "practical tests" which kind of pipe, as sold on the market, was the more durable. The first attempt to get this information was by circularizing about 300 heating engineers and contractors; asking for samples of corroded pipe, which had been in service only a few years, with a full history of each sample. Only ten samples were received that had given out within four years, and of these six were steel and four were of wrought-iron. While it would seem that the number of samples examined was far too small to allow general conclusions of any great value, yet it is of interest to quote Mr. Thomson:

> A study of the samples received from the trade leads to the assumption that: (1) both wrought-iron and steel pipes which convey steam or hot water will corrode very rapidly when buried underground in wet or damp soil or ashes, the corrosion being principally external; (2) both wrought-iron and steel pipes which convey hot water become rapidly corroded if the air and other gases naturally solvent in the water are not permitted to escape from the water previous to its passage through the pipes, as in feed-water heater connections and hot-water circulation pipes for plumbing purposes, this corrosion being principally internal if the pipes are not buried underground; (3) the life of either wrought-iron or steel pipes subject to both of the aforesaid conditions will be much shorter than if the pipes are subject to only one of them, because the metal will thus become rapidly corroded at both the internal and external surfaces; (4) it is not a fact that the destruction of wrought-iron pipes is in the form of a uniform corrosion, while the destruction of steel pipes is in the form of pitting; they appear to be on an average nearly alike with the difference, if any, in favor of steel.

To further test both iron and steel commercial pipe under identical same conditions of service, samples, some obtained from local heating contractors and some from a manufacturer, were inserted in a hot water circulating system arranged as follows:

> A 100-gal. galvanized iron boiler in the engine room was heated by a 1-in. brass steam coil inside. The boiler furnished hot water to 24 cocks at eight sinks. The water came from the city mains at a pressure of 85 to 135 lbs. per sq. in. An analysis of the water at the time showed:
>
> | | | | | |
> |---|---|---|---|---|
> | CO_2 and Organic matter | 29.33 | parts | per | million. |
> | Silica | 4.00 | " | " | " |
> | Iron oxide | 0.43 | " | " | " |
> | Alumina | 0.37 | " | " | " |
> | Calcium carbonate | 4.82 | " | " | " |
> | Magnesium | Trace | " | " | " |
> | Sulphur trioxide | Trace | " | " | " |
> | Sodium chloride | 0.82 | " | " | " |
>
> The water on being heated in the boiler circulates between the boiler and the sink cocks, up through the flow pipe and back through the return pipe. These pipe lines are all composed of annealed brass pipe tinned both outside and inside and connected with heavy cast brass beaded fittings. A piece of 2-in. pipe 10 ft. long, was removed and replaced with ten short samples of 2-in. iron and steel pipe screwed together. The temperature of the water as it flows through this pipe varies presumably from about 160° to 212°, and the supply of hot water is maintained day and night all the year around.
>
> Owing to the fact that these iron samples were connected to brass pipes, and also because a large amount of machinery was driven by individual electric motors we wired and cross-wired the pipes with copper wire, connecting the ends with perfect contacts to the brass mains. This was done under advice from electrical experts to carry any stray current around the samples and thus avoid decomposition due to electrolytic action. It was thought this precaution would insure a corrosion that would be due to nothing but the ordinary action of the hot water on each sample, and that no sample would be favored in any way. The samples were installed March 7, 1906; were removed March 14, 1907, and were in constant service during that time. The velocity of flow was always low; never high enough to wash out the rust formed.

It should be noted here that, in spite of the advice from "electrical experts," while the wiring of the iron to the brass pipes may have shunted stray currents from the electrical machinery in case it was "grounded" there was still present an optimum condition for corrosion which was only increased by this wiring. There was then brass (or tin) in metallic contact with the iron (or steel), and both immersed in a dilute electrolyte. It would have been a nearer approach toward eliminating the more-than-local electrolytic action to have insulated the iron from the brass pipes and perhaps better still to have insulated each sample of iron and steel pipe from every other one. The two brass pipe ends could then have been well connected by by-pass wires to have shunted stray currents to earth.

The minimum weight lost by any sample was 1.8% (with galvanized iron), and the maximum was 17.8%, while the average of ungalvanized pipe was 15.2%. The average loss of the galvanized samples was 2.5%. Had the corrosion continued at the rate shown by the deepest spots on each sample the black pipes would have been penetrated in from 686 to 850 days, and the galvanized in from 619 to 1163 days, the average life of these two groups being 770 and 929 days, respectively. These figures indicate that some action not commonly present in practice was present during this test. In the discussion of this paper Prof. Wm. Kent, Syracuse University, emphasized the futility of basing any explanation of corrosion on mere general appearance and stated that had a complete chemical and microscopical examination been made of these ten samples, some clue might have resulted that could have led to a remedy.

The most of the remaining time of the last professional session was an "experience meeting" on air filters and washers.

At the business session the following board of officers was elected:

President—James Mackay, Chicago, Ill.

1st Vice-President—James D. Hoffman, La Fayette, Ind.

2d Vice-President—B. F. Stangland, New York City.

Secretary—W. M. Mackay, New York City.

Treasurer—V. G. Scollay, Brooklyn, N. Y.

Board of Governors—C. B. J. Snyder, New York City; R. C. Carpenter, Ithaca, N. Y.; August Kehm, Chicago, Ill.; J. F. Hale, Chicago, Ill.

DATA FOR THE DESIGN OF HOT-WATER HEATING SYSTEMS.*

After three preliminary reports, in which were submitted a plan of procedure, replies to questions sent out, and the results of tests made, the Committee beg leave to submit as a final report the accompanying notes, which are from (1) text-books and publications of prominent engineers, (2) practice of engineers and contractors as shown by some sixty replies to letters asking for data, (3) experience of and tests secured by the Committee, (4) study and comparison of trade catalogs and information given by manufacturers.

DIRECT RADIATION.—The best practice calls for the use of the heat unit as a basis for computing the amount of radiation required. Within the ordinary range of temperature, the losses in B.T.U. per sq. ft. per hour through various substances, as given in Table I. seem to be conservative.

Table I.—Radiation Losses Through Buildings.

Temperature outside	40	30	20	10	0	−10	−20
Temperature inside	70	70	70	70	70	70	70
8-in. brick wall	13	18	22	27	31	36	40
12-in. brick wall	10	13	16	20	23	26	30
16-in. brick wall	8	10	13	16	19	22	24
20-in. brick wall	7	9	11	14	16	18	20
24-in. brick wall	6	8	10	12	14	16	18
Single window	36	49	60	73	85	93	105
Double window	24	32	40	48	56	62	70
Single skylight	31	42	52	63	73	84	94
8-in. frame housewall plastered inside	8	10	13	16	19	22	24
Cold ceiling or floor areas	5	6	8	10	11	13	15

The heat lost through surfaces exposed to cold may be found by using the above multipliers. The results should be increased by 30% as an allowance for leakage; or in rooms with three or four sides exposed, the leakage may be assumed as ordinarily not exceeding one change of air per hour, and the B.T.U. lost in this way may be determined as follows:

$$\frac{C \times (T - T_1)}{55} = L$$

where C = contents of room; T = temperature desired; T_1 = outside temperature.

55 is approximately the number of cu. ft. of air raised 1° by 1 B.T.U. L = B.T.U. leakage loss.

The glass area should be deducted from the exposed wall area before multiplying. The table is for southern exposure. Additions should further be made as follows: north, 30%; east, 10%; west, 20%. This addition is for the increased transmission of heat due to wind, and must be used with judgment and consideration of the locality of the building.

The total B.T.U. as obtained above, after additions for leakage and exposure have been made, is to be divided by 150 for hot-water heating, as this is a conservative estimate of the amount of heat given off per hour by one square foot of ordinary cast-iron radiation with the room at 70° and the water at an average temperature of 170°. The quotient is the amount of direct radiation needed.

INDIRECT RADIATION.—The amount of indirect radiation required may be worked out by assuming the following:

The values shown in parentheses are probably correct with indirect hot water.

Temperature of the air entering the room (110°).

Average temperature of the air passing through the radiator (55°).

Temperature of the air leaving the room (70°).

Velocity of the air passing through the radiator (240 ft. per min.)

Having found the loss of heat by exposure, to find the cubic feet of air necessary to carry this to the room at the given temperature:

$$\frac{H \times 55}{T_2 - T_3} = \text{cubic feet of air per hour.}$$

where H = exposure loss in B.T.U. per hour; T_2 = temperature of the air entering the room; T_3 = temperature of the air leaving the room.

Given this volume of air to find the heat necessary to raise it to the entering temperature:

$$\frac{(T_2 - T_1) \times Q}{55} = \text{B.T.U.}$$

where Q = cu. ft. per hr.

The amount of radiation is found by dividing the total heat by the specific radiation at the velocity and temperature difference assumed, as indicated in Table II.

The difference between 170° (average temperature of the water in the radiator) and 55° (average temperature of the air in the radiator) being 115°, the emission at 240 ft. velocity per min. is 2. per degree difference or 230 B.T.U.

Ordinarily the amount of indirect radiation required is computed by adding a percentage to the amount of

*A revised report of the Committee on Hot Water Heating, presented at the 14th Annual Meeting, New York City, Jan. 22, 1908. Jas. Mackay (Chairman), E. F. Capron, S. R. Lewis, Committee.

TABLE II.

The Emission of Heat by Indirect Radiators per sq. ft. per hr. per Degree Difference in Temperature.

Velocity of Air in ft. per min.	B.T.U.
174	1.70
246	2.00
300	2.22
342	2.38
378	2.52
408	2.60
438	2.67
450	2.72
474	2.76
492	2.80

direct radiation, and an addition of 50% has been found sufficient in many cases; but in buildings where a standard of ventilation is to be maintained, the above formula seems more likely to give satisfactory results. Free area between the sections of radiation to allow passage of the required volume of air at the assumed velocity must be carefully maintained. The cold-air supply duct, on account of less frictional resistance, may ordinarily have 80% of the area between the radiator sections.

BOILERS.—Many boilers for residence heating are not rated satisfactorily in the catalogs. Among twelve familiar types the hot-water rating for the same grate surface varies from 2,800 to 3,875 sq. ft. The amount of fire surface is not generally published and information is difficult to obtain. It probably varies 50% among these same 12 types.

Given proper combustion and sufficient length of fire travel to prevent excessive draft, the amount of heating surface is apparently not a prime factor, as boilers with large combustion chambers and comparatively small heating surface have surpassed the performances of other boilers of the same type and grate area with small combustion chambers and large heating surface.

A restricted combustion chamber is kept at rather a low temperature by the proximity of the water-cooled surfaces and the high temperature of good combustion is difficult to obtain. As a rule, the longer and higher the fire-box the better the combustion. Apparently 8,000 B. T. U. per lb. of coal is a conservative average estimate of the heat transmitted to the water in a well-designed boiler, after allowances for various causes commonly affecting the efficiency have been made. Hard coal usually gives off more heat per lb. than soft coal, but on account of the more rapid combustion of soft coal the final results of the two fuels about balance. Thus, if we divide the heat given off per hour by the radiation and piping by the effective value of the coal, we have an estimate of the pounds of coal that must be burned per hour.

The grate surface to be provided depends on the rate of combustion, and this in turn depends on the attendance and draft, and on the size of the boiler. Small boilers are usually proportioned with a small amount of fire surface per unit of grate, and thus are adapted for intermittent attention and a slow rate of combustion. The larger the boiler the more attention is given to it, and the more heating surface is provided per sq. ft. of grate. The rates of combustion shown in Table III are common for internally-fired heating-boilers:

TABLE III.

Sq. ft. of grate.	Lbs. of coal per sq. ft. per hr.
4 to 8	Not exceeding 4 lbs.
10 to 18	" " 6 "
20 to 30	" " 10 "

The number of pounds of coal to be burned per hour divided by the rate of combustion indicates the size of the grate required.

It is desirable so to proportion residence boilers that attention need ordinarily be given them only about once every 8 hrs. The fire-box should be sufficiently large to hold this amount of coal with its attendant ash and clinker and still leave ample room for the mixture of the products of combustion.

Multiplying the amount of coal required per hr. by the number of hours intervening between replenishments and adding 20% for ash and clinkers gives a conservative estimate of the number of lbs. of coal to be accommodated. This divided by 50, the number of lbs. of ordinary coal in 1 cu. ft., gives the space occupied by the fuel. As this

TABLE IV.

SIZES OF PIPE FOR HOT-WATER HEATING.

	Mains.	Pipe.	Velocity per minute.
2 pipe, open tank system.....	100 ft.	5 in.	=26.6 ft.
1 pipe, open tank system.....	100 ft.	6 in.	=18.4 ft.
Overhead, open tank system...	100 ft.	4 in.	=41.8 ft.
Overhead, open tank system...	100 ft.	3 in.	=72.1 ft.

For 1,300 sq. ft. indirect radiation with separate main, 160 ft. long, direct from boiler, open system, the bottom of the radiator being 1 ft. above the top of the boiler—5-in. pipe = 2.4 ft. velocity per min.

The above velocities are calculated as follows:

$$\frac{R \times X}{20 \times 60.8 \times 60} = \text{cu. ft. of water per min.}$$

R = sq. ft. of radiation: X = B. T. U. given off per hour by 1 sq. ft. of radiation (150 for direct and 230 for indirect) with water at 170°; 20 is the drop in temperature in degrees between the water entering the radiation and that leaving it: 60.8 is the weight of a cu. ft. of water at 170°: 60 is to reduce the result from hours to minutes.

should not exceed about one-third of the total height of the fire-box for soft coal, this sum multiplied by three gives the fire-box capacity in cu. ft. for soft coal. Multiplying the fuel space by two is believed to give ample combustion space for hard coal. Combustion must be completed in the fire-box of the ordinary boiler or it is never completed, as the flues are merely economizers acting to cool down the products of the combustion before entering the chimney.

PIPING.—The average sizes of mains, as used by seven prominent engineers in regular practice for 1,800 sq. ft. of radiation, are given in Table IV.

The following is taken from "Principles of Heating," by Wm. G. Snow:

If the volume of water passing through pipes of different sizes is known, the radiating surface they will supply may be readily computed. With the same drop in temperature in radiators, the force causing circulation will be alike in all. With pipes of equal length, the resistance will vary, as the square of the velocity and inversely as the diameter expressed as $\frac{V^2}{d}$. Now, if we assume, for example, that a 2-in. pipe will supply 200 sq. ft. of direct radiation, which in practice it will readily do, and compute the value of $\frac{V^2}{d}$, then make $\frac{V^2}{d}$ the same for pipes of other sizes, a table may be prepared showing the radiating surface that may be supplied by pipes of different diameters when working under the same conditions with respect to the head causing the flow and the resistance to the circulation.

As the velocities stated agree with the practice of the seven engineers above tabulated for a two-pipe open system, Table V has been prepared, using Mr. Snow's table

FIG. 1. FOUNDATION PIT WITH NYE STEEL CHANNEL SHEETING AND I-BEAM WALES; PITTSBURG PLATE GLASS CO., CRYSTAL CITY, MO.

as a basis, and changing the amounts of radiation supplied under other conditions in proportion as these given by him vary for other sizes of pipe.

The capacities of risers for different floors, from data

TABLE V.

THE CAPACITY OF MAINS 100 FT. LONG.—Expressed in the number of sq. ft. of hot-water radiating surface they will supply, the radiators being placed in rooms at 70° F., and 20° drop being assumed.

Diameter of pipes.	2-pipe up feed open tank—Direct radiation.	1-pipe up feed open tank—Direct radiation.	Overhead open tank—Direct radiation.	Overhead closed tank—Direct radiation.	2-pipe open tank—Indirect (12 ins. above boiler.)
1¼ in.	75	45	127	250	48
1½ in.	107	65	181	335	69
2 in.	200	121	339	667	129
2½ in.	314	190	533	1,060	202
3 in.	540	328	916	1,800	348
3½ in.	780	474	1,334	2,600	502
4 in.	1,060	645	1,800	3,350	684
5 in.	1,860	1,130	3,150	6,200	1,200
6 in.	2,960	1,800	5,000	9,800	1,910
7 in.	4,280	2,700	7,200	13,900	2,760
8 in.	5,850	3,500	9,900	19,500	3,778

TABLE VI.

THE CAPACITY OF RISERS.—Expressed in the number of square feet of direct hot-water radiating surface, they will supply the radiators being placed in rooms at 70° F. and 20° drop being assumed:

Diam. of Riser. Inches.	Open Tank System. 1st Floor.	2nd Floor.	3rd Floor.	4th Floor.	Closed Tank Overhead System. Drop risers, not exceeding 4 floors.
1	33	46	57	64	48
1¼	71	104	124	142	112
1½	100	140	175	200	160
2	187	262	325	375	300
2½	292	410	492	580	471
3	500	755	875	1,000	810

obtained from nine engineers, in the same manner, agree almost exactly with Mr. Snow's table given below for an open tank system. The table for an overhead closed tank system is proportional to Mr. Snow's table for mains, using as a basis 300 sq. ft. of radiation on a 2-in. riser.

Inasmuch as radiators are commonly tapped 1 inch up to 40 sq. ft., 1¼ ins. from 40 to 72 sq. ft., and 1½ ins. for larger than 72 sq. ft., little is to be said about the size of radiator connections. One prominent engineer states that with one pipe overhead circulation he has never found a radiator so large that 1½-in. connection would not supply it.

Another states that he has been using with perfect satisfaction special radiator tappings side by side at the bottom of one end of each radiator. This results in economy of installation and a neater appearance of the work.

NEW SYSTEMS OF STEEL SHEET PILING WITH CLAMP CONNECTIONS.

In most of the designs of steel sheet piling the adjacent piles interlock with each other for their full length, which necessitates the use of built-up piles or rolled sections of special form. In two recent cases, however, steel sheeting has been used in which all the piles are ordinary commercial steel channels or I-beams, connected at top and bottom by special locks or clamps.

PITTSBURG PLATE GLASS CO.'S PLANT.

One of these cases was at Crystal City, Mo., where the sheeting was used in the construction of the first eight foundation pits for the new plant of the Pittsburg Plate Glass Co. A view of the completed sheeting, with I-beam and timber wales is shown in Fig. 1. The contractor for the pits is Mr. S. Casparis, of Columbus, Ohio. The pit is about 22 × 26 ft. in plan, and 40 ft. deep. About 20 ft. below the surface there is a 12-in. vein of quicksand, the material above and below this being clay. This work was started with wooden sheeting, carried down horizontally to a depth of 18 ft. The work proceeded so slowly in going through the quicksand that Mr. C. C. Stutz, Chief Engineer of the Pittsburg Plate Glass Co., decided to use the Nye system of steel sheet piling, which is owned by the National Interlocking Steel Sheeting Co., of Chicago.

The piles are 15-in., 33-lb. channels, 40 ft. long, with flanges overlapping and connected by clamps, as shown in Fig. 2. Each lock fits over the flanges of two adjacent piles and the bottom lock also fits over the bottom edge of one pile. The general construction is shown in the upper part of Fig. 2. The lower part shows a special arrangement for cofferdams, in which a wooden strip is fitted between the adjacent flanges of the piles to make a watertight joint. The piles were driven by an ordinary pile driver, using an 1,800-

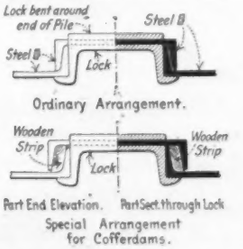

Fig. 2. Sections of Nye Steel Sheet Piling, Consisting of Channels Connected by Clamps at Top and Bottom.

lb. hammer, and were held in place in the leads by a special follower cap made by the Curtis Steel Foundry, of St. Louis. The sheeting was braced by waling on the inside, three of the waling courses being steel I-beams; these are seen

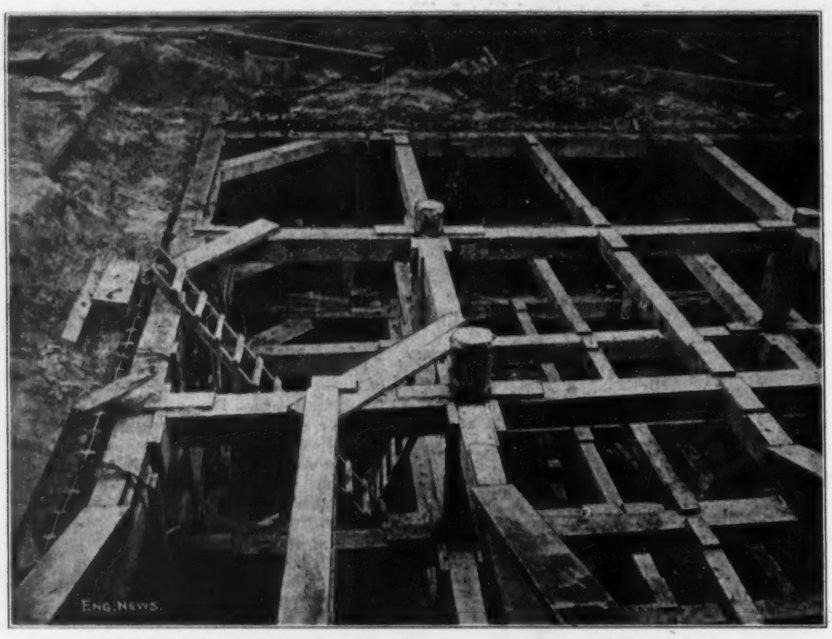

FIG. 3. EXCAVATION 40 x 132 FT. LINED WITH JACKSON I-BEAM SHEETING; STEELE-WEDELES WAREHOUSE BUILDING, CHICAGO.

in the second and fourth courses shown in Fig. 1. After the sheeting was completed, very little water entered the pit. A 2-in. siphon could empty the pit each morning, and there would be no more pumping necessary during the day.

STEELE-WEDELES CO. WAREHOUSE.

The other case referred to is in the underground portion of the new warehouse for the Steele-Wedeles Co., wholesale grocers, at Chicago. Mr. Henry L. Ottenheimer is the architect for the building, which is located at Dearborn St. and the Chicago River. It is 80 × 180 ft. in plan. The interesting feature of this building is a four-story sub-basement about 33 × 125 ft. in the clear, the bottom floor of which (42 ft. below the water line, or Chicago datum) forms a private freight station on the freight-handling tunnel system of the Illinois Tunnel Co. The tunnels, which are 6 × 7½ ft., enter the sub-basement at each end and each side. An excavation 40 × 132 ft. was made for this sub-basement, and is lined with sheet piling of steel I-beams connected by clamps, as described below. The same sheeting is used for a shaft 22 × 22 ft., in which will be an elevator to handle the narrow gage cars between the tunnel tracks and the warehouse floor. The piling was all driven before excavation was commenced, and the waling courses and bracing were put in as the enclosed material was removed. Fig. 3 is a view of one end of the large excavation, showing the I-beam sheet piling, with timber wales and bracing. Beyond the cofferdam may be seen one of the built-up steel rings used for the cylindrical caissons for the smaller column foundations of the building.

The piles are ordinary 12-in. steel I-beams, and near the top and bottom of each pile is a pair of forged steel clamps. These are bolted to the web, and so shaped as to engage the flanges of two adjacent beams. The construction is shown in Fig. 4. The bottom clamps, A, for each new pile, are bolted on when the end of the pile has passed through the top clamps, B, of the adjacent pile. All nuts are placed on the inside of the piles. For very long piles, clamps may be fitted at intermediate points if required. The clamp work is small, and the parts can be assembled quickly in the field. The steel sheeting in the case mentioned is in 45-ft. lengths, and was driven through quicksand into hard clay, the top of the sheeting being about 2 ft. above the water level in the river. The patents on the locking clamps are owned by the firm of Geo. W. Jackson of Chicago, which has the contract for the underground work of the warehouse; this firm also owns the patents on the Jackson interlocking sheet piling which has been described in our columns. The firm, however, sells the clamps to engineers and contractors who wish to use I-beam sheeting.

The deep sub-basement construction is shown in Fig. 5, and it will be seen that the column footings are about 65 ft. below datum. The excavation is lined with a 30-in. wall of concrete, placed close to the steel lining. The shaft, 22 × 22 ft., already mentioned, is in one corner of the building, and contains four column foundations as well as the elevator. The platform is 14 ft. 6 ins. × 8 ft. 8 ins. with a track of 24 ins. gage for the tunnel cars. The construction is shown in Fig. 6, and is typical of the elevator connections

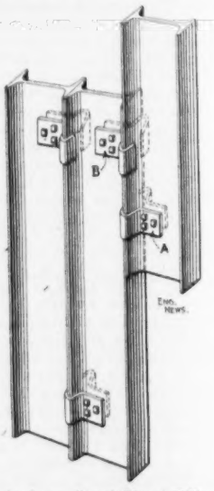

Fig. 4. The Jackson Steel Sheet Piling of I-Beams with Bolted Clamps.

now provided at a number of warehouses, railway stations, etc., for handling cars carrying mail, freight, etc., in the 30 or 40-mile system of deep-level tunnels now in service in Chicago.

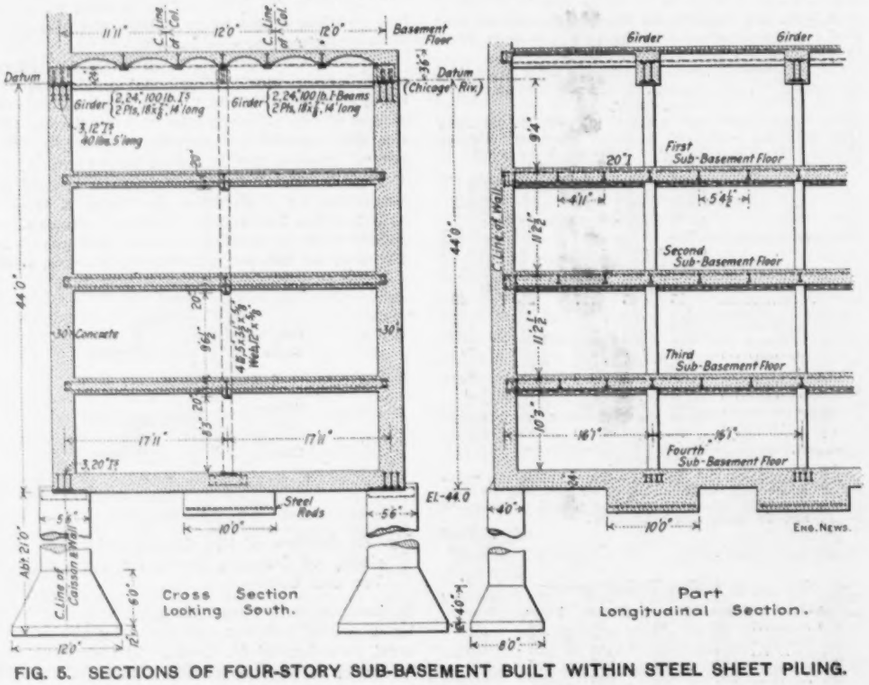

FIG. 5. SECTIONS OF FOUR-STORY SUB-BASEMENT BUILT WITHIN STEEL SHEET PILING.

A BOILER EXPLOSION in a sawmill at Gilliam, La., on Jan. 25, resulted in the death of three men and the serious injury of four others.

THE BOYERTOWN FIRE numbered its 169th victim by the death on Jan. 27 of one of the injured. The first reports, as noted in our issue of Jan. 16, indicated that over 200 persons lost their lives in the fire, but a number of those supposed to have been lost were afterward reported as safe.

THE CITY HALL OF PORTLAND, ME., was badly damaged by fire on Jan. 23. It is believed that most of the city records were lost, and in addition many of the county records were destroyed. The cause of the fire is attributed to the crossing of wires of the city electrical department. The building was a three-story-and-basement structure, with some rooms on the fourth floor.

A HEAD-ON COLLISION between a freight and a passenger train and the additional collision of a third train with the wreckage caused the death of ten persons and the injury of many others on the line between Milan and Rome, Italy, on the night of Jan. 20. Three men were killed and two perhaps fatally injured near Corydon Junction, Ind., on Jan. 19, when an engine of the Southern Indiana Ry. plunged from a 90-ft. trestle, dragging with it two freight cars and a caboose. Three men were killed on the Atlanta, Birmingham & Atlantic R. R. at

Stop, Ga., on Jan. 20, by a wreck resulting from a derailment caused by a telegraph pole placed across the track, probably with evil design.

AN ELECTROLYSIS SUIT for damages to water mains has been brought against the Philadelphia Rapid Transit Co. by the North Springfield Water Co., which latter supplies a portion of the 22d Ward of Philadelphia and four townships in Montgomery County.

A CONFERENCE OF DISTRICT ENGINEERS of the water resources branch of the U. S. Geological Survey was held at Washington during the week ending Jan. 25. Methods of work, instruments and equipment, cost-keeping systems, the debris problem of California rivers, and numerous other topics were discussed. Mr. Marshall O. Leighton, Assoc. M. Am. Soc. C. E., is Chief Hydrographer of the Survey.

THE ASSOCIATION OF LICENSED CEMENT MANUFACTURERS has recently been organized by a number of the leading Portland cement manufacturing companies which are now working under the Hurry and Seaman, Edison, Carpenter and other patents now controlled by the North American Portland Cement Co. All companies using these patents will be licensed and admitted to the association. According to a statement recently issued by the association, its purposes include the general betterment of the mechanical and chemical processes used in making cement, the improvement of the quality of cement, dealing with matters of traffic and shipment and the establishment of an association laboratory for technical tests and experiments.

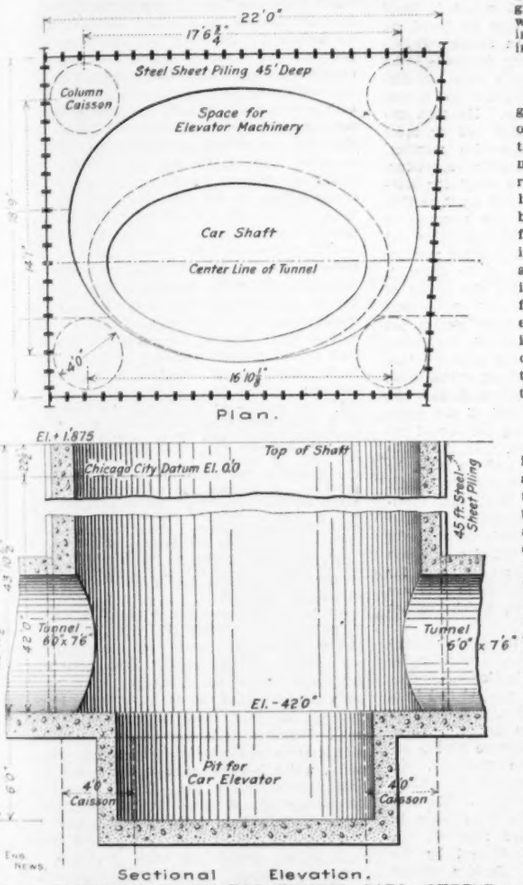

FIG. 6. ELEVATOR SHAFT FOR TUNNEL CARS; STEELE-WEDELES CO. WAREHOUSE, CHICAGO.

THE CONTRACT FOR THE BELLE FOURCHE IRRIGATION project dam and irrigation canals, in South Dakota, held by Orman & Crook, of Pueblo, Colo., has been suspended by the Secretary of the Interior, and all machinery, tools, animals and materials on the ground have been taken possession of by the Government. The manner of completing the work has not yet been decided. The contract was entered into on Nov. 14, 1905, at a total estimated cost of $1,003,299. The work is one of many irrigation projects being carried out by the U. S. Reclamation Service.

FORCE-ACCOUNT WORK, in place of a contract, is credited by the U. S. Reclamation Service with a large saving on the Tieton Irrigation Project, Washington. Bids for this work, which involves both open and tunnel excavation, were invited for Nov. 15, 1906, but none were received. An informal advertisement, made through the local engineer's office at North Yakima, Wash., resulted in only one bid for the entire work. This was submitted by the Puget Sound Bridge & Dredging Co., of Seattle, Wash. For open canal excavation, the company bid as follows, on various classes: 73 cts. per cu. yd., for Class 1; 90 cts. per cu. yd., for Class 2; $1.27 per cu. yd., for Class 3; $2.25 per cu. yd., for Class 4. For tunnel excavation the bid was $24.85 per lin. ft. The bid was rejected as too high, and the work was taken up by the Reclamation Service direct. The results thus far achieved, as stated by Mr. F. H. Newell, Director of the U. S. Reclamation Service in response to a request from this journal, are as follows:

At the present time there has been excavated 1,000 cu. yds. of Class 2 at cost of 50 cts. per cu. yd., and 2,690 cu. yds. of Class 4 at a cost of $1.50 per cu. yd. In the tunnel work there has been excavated 3,240 lin. ft. at a cost of $22.60 per lin. ft., and since reorganization of the force conducting this work there has been excavated 775 lin. ft. at a unit cost of $16.80. It is believed that the unit cost of the tunnel excavation hereafter under the new organization will not exceed this amount as there were no unusual factors tending to reduce the cost as given under the new organization. The cost of the force account work as here stated includes all engineering and administrative expenses, including the Washington office.

THE EXCHANGE OF WIRELESS telegrams by all private enterprises with all other ships and stations, without distinction of the system adopted or the commercial agreements already in force, as required by the Berlin international wireless-telegraphy convention of 1906 has been formally objected to by the counsel for the Marconi Wireless Telegraph Co., in a memorandum presented to the Senate Committee on Foreign Relations. It is claimed that in most cases the confirmation of the Berlin convention will enforce a partnership on the Marconi Co., in which this company contributes all the capital, invention and enterprise and all the advantages of the partnership pass to the German concerns involved.

THE BROOKLYN BRIDGE TERMINAL in New York City began operation under a new system on Jan. 26. The cable traction, which has been in use ever since the bridge was opened to traffic, 24 years ago, has been abandoned and with it the operation of local bridge trains. Instead the trains across the bridge now run through to destination over various lines of the Brooklyn Elevated Ry. system, and the change of cars at the Brooklyn end of the bridge is avoided. In addition, six-car trains replace the five-car trains operated with the cable system, and it is expected to operate these on a headway of 60 seconds in the rush hours. The local traffic across the bridge from terminal to terminal is to be handled by special trolley cars running on the bridge roadways.

In the first operation of the new system on Monday, Jan. 27, confusion resulted from the unfamiliarity of employees and passengers with the method of operation. This was added to by the stalling of a train on which a fuse blew out and consequent blockade of traffic. As the bridge railway is now carrying an average traffic of about 426,000 passengers daily, any interruption of the train movement during rush hours has an effect like damming a torrent. It is believed, however, that the new method of operation will shortly prove its great advantage over the old.

THE NEW COUNTY BUILDING at Chicago, now completed, is an example of rapid construction work. The annual message of Mr. William Busse, President of the Board of Commissioners of Cook County, states that within 22 months after the last department had moved out of the old building (on the same site) the first one had moved into the new building. On Aug. 26, 1905, the wrecking of the old building was commenced, and the last occupants moved out on Sept. 9. The work on the foundations was commenced Jan. 4, 1906, and were completed on May 14. The first steel was set on June 12, 1906, and the first granite block was laid on Aug. 28. On July 5 and 6, 1906, the County Court moved into the new building, and held a session on July 8. Within 23 months from the time the first work was done on the new structure, 130 caissons (averaging 115 ft. in depth) were sunk, and 450,000 cu. ft. of concrete were put in them; 11,000 tons of steel framework were erected, and 14,000 tons of granite and 6,000,000 brick were placed around it. The heating and ventilating apparatus, plumbing appliances, electric wiring and water service for 12,000,000 cu. ft. of space were installed. The interior finishings of ten floors, each occupying an acre of space, were completed, and hundreds of tons of furniture and public records were moved into the new building. The Wm. Grace Co. had the general contract. Mr. William Holabird (of Holabird & Roche) was Superintendent Architect; and Mr. John M. Ewen was Consulting Engineer to the Board of County Commissioners.

AN INTERNATIONAL EXHIBITION of the applications of electricity will be held at Marseilles, France, from April 19 to Oct. 31. The exhibition is open to all countries and all manufacturers are solicited to show lines of apparatus. There are to be 17 principal sections which will include transmission, distribution and utilization in all possible ways, industrial, domestic, agricultural, military, naval, medical, etc. This exhibition has been arranged to bring a better knowledge in southeastern France of the possibilities of utilizing the advantages of a system of hydro-electric stations, having a capacity of 150,000 HP., which has been developed. The town of Marseilles has placed at the disposal of the exhibition the 60-acre park of the "Rond Point du Prado." A bureau has been established, under the direction of the Commissioner General, for the convenience of exhibitors who are unable to give personal attention to their exhibits. The bureau assumes charge of the erection, repair, maintenance and proper working of exhibits as well as the packing and return shipment at the end of the exhibition period. The cost of space is $19.30 for the first square meter and from $15.50 to $5.80 per sq. meter for additional space. Direct and alternating current will be supplied for lighting at about 15.5 cts. per KW.-hr. and for power and heating at 9.7 cts. per KW.-hr., with a sliding scale according to consumption. Mr. Paul Diény, Commissioner for the United States, has established offices at the Park Row Bldg., New York City.

THE PURCHASE, SALE AND CONSOLIDATION OF gas and electric companies in Massachusetts has been reported on by the Gas and Electric Light Commissioners of that State, in accordance with instructions of the Legislature. The board concludes that while economy and efficiency are favored by large gas or electric plants operating in a given area, as compared with several small plants serving different sections, and while, on the one hand, there may be benefit in consolidating the gas and electric supply in small municipalities in order to give financial and operative strength, the public, on the other hand, is not sufficiently benefited by the consolidation of gas and electric interests in cities of considerable size to offset the disadvantages that arise from such consolidation. Particular mention is made of the difficulties in determining the proper price for service that arise when one company is supplying both gas and electricity. The board has submitted to the Legislature the draft of a bill authorizing the consolidation of gas companies operating in contiguous municipalities, and also authorizing similar consolidations of electric companies, providing that all such consolidations are approved by at least two-thirds of the stockholders of each company, and also by the board, after advertisement and public hearing. The proposed act prohibits the consolidation of gas and electric companies, with an exception based on certain existing legislation.

FOREST PLANTING by the Louisville & Nashville Ry. is briefly described in "Arboriculture" for January. At Carney, in Baldwin County, Ala., some 30 miles northeast of Mobile, the railway has bought 1,040 acres of land from which a heavy growth of yellow pine had been cut. This was replanted in 1906 and 1907 with Catalpa speciosa trees, set 7 x 7 ft. In December, 1907, 600,000 Catalpa speciosa trees were shipped to Alabama for use on two tracts owned by the railway company. It is expected that in seven or eight years after the date of planting, the trees will be thinned to 14 x 14 ft. apart, yielding two or three sticks per tree large enough for mine timbers. In some 12 to 14 years, it is also expected that the trees will be large enough for cross-ties. The soil in this section is a red clay with a large mixture of sand, and is said to be fertile. In deep railway cuttings it is apparent that the long-leaf yellow pine sent its tap-roots down to a depth of 10 or 12 ft.

PERSONALS.

Mr. George W. Payne has been appointed Chief Engineer of the Missouri Southern R. R., with headquarters at Leeper, Mo.

Mr. J. B. Cox, formerly Chief Engineer of the Chicago Junction Ry., has taken up private practice as a consulting engineer, with offices at 1741 Railway Exchange Building, Chicago.

Mr. S. H. Reynolds, for the past seven years Asst. City Engineer of Winnipeg, Man., has resigned to accept the position of Managing Director of the South Wellington Coal Mine Co., Victoria, B. C.

Mr. J. H. Von Engelkin has been appointed to the newly instituted office of Sanitary Inspector of the Atchison, Topeka & Santa Fe R. R. This office is the result of a recent law in the State of Texas.

Mr. G. P. DeWolf, formerly Engineer of Maintenance of Way of the Mexican International R. R., has been given charge of the maintenance of way of the entire National Lines of Mexico, with headquarters in the City of Mexico.

Mr. Thomas Fitzgerald has resigned the position of General Manager of the Baltimore & Ohio R. R. and in the future the engineering department is to be under the general direction of Mr. G. L. Potter, third Vice-President of the road.

Mr. J. R. Cameron, formerly Superintendent of the Canadian Northern R. R. at Port Arthur, Ontario, has been appointed General Superintendent of the same road, with headquarters at Winnipeg. He has been succeeded at Port Arthur by Mr. A. Wilcox.

Mr. J. Edward Simmons, Chairman of the Board of Water Supply of New York City, presented his resignation to the Mayor after the exoneration of the Board of all blame in the matter of the awarding of the contract for the Ashokan Dam, the investigation of which has been reported in our previous issues.

Obituary.

Anthony P. Smith, President of the A. P. Smith Manufacturing Co., of Newark, N. J., and one of the pioneer workers in water-works machinery in this country, died at his home in Newark, on Jan. 21, at the age of 61 years.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 3-8. Annual meeting at Columbus, Ohio. Secy., Theo. A. Randall, Indianapolis, Ind.

AMERICAN CERAMIC SOCIETY.
Feb. 3-5. Annual meeting at Columbus, Ohio. Secy., Edw. Orton, Jr., Columbus, Ohio.

AMERICAN SOCIETY OF PLUMBING INSPECTORS AND SANITARY ENGINEERS.
Feb. 10-12, 1908. Annual meeting at Chicago, Ill. Secy., Garrett W. Cotter, 44 East 23d St., New York City.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 11-12. Annual meeting at New Haven. Secy., T. F. Jackson, New Haven.

OHIO ENGINEERING SOCIETY.
Feb. 11-13. Annual meeting at Columbus. Secy., E. G. Bradbury, 85 North High St., Columbus.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 18. Annual meeting at New York. Secy., R. W. Raymond, 29 West 39th St., New York.

AMERICAN WATER-WORKS ASSOCIATION.—The 28th annual convention has been announced for May 11-16, 1908, at Washington, D. C.

THE AMERICAN SOCIETY OF INSPECTORS OF PLUMBING AND SANITARY ENGINEERS will hold its third annual meeting at the Great Northern Hotel in Chicago, Ill., from Feb. 10 to 12. Twenty-eight papers are to be presented during the three days' session, covering a wide field in the larger problems of house sanitation. Probably the most important of these will be a paper by Mr. John K. Allen, of Chicago, on "Public Comfort Stations," which will be about the first general presentation of this subject ever made. Other important papers: "Sterilized Water Supply for Large Buildings," by J. N. Thomson, of Scranton, Pa.; "Broad Irrigation with Sewage in Southern California," by A. C. Shaver, Pasadena, Cal., and "Domestic Septic Tanks," by H. F. Shade, Vancouver, B. C.

INTERNATIONAL UNION OF STREET AND LIGHT RAILWAYS.—The following list of subjects has been prepared for consideration at the biennial international congress to be held at Munich, Germany, in September, 1908. (1) Corrugations or undulatory wear of rails; report of a special commission. (2) Generation of electric current by steam and water power, etc., Mr. Rizzo, Brussels. (3) Different types of street cars, Mr. Spangler, Vienna. (4) Development in system of brakes on electric lines, Mr. Petit, Brussels; Mr. Schottes, Nuremburg, and Mr. Schorling, Hanover. (5) Results obtained by the use of current meters on electric cars, Mr. Battes, Frankfort, and Mr. Otto, Berlin. (6) The use of electric traction on local and light railways, Mr. Reichel, Berlin. (7) Wear and durability of parts of rolling stock, Mr. Stahl, Dusseldorf. (8) Advantages and disadvantages of the motor omnibus, Mr. Mauclere, Paris, and Mr. Otto, Berlin. (9) Lubrication of bearings and gears, Mr. Julius, Haarlem. (10) Track construction of local and light railways. (A) Size and weight of ties; (B) Depth of ballast; (C) The rail section; (D) The use of ties of steel and reinforced concrete; (E) The maintenance and inspection of rail joints; Mr. de Burlet, Brussels. (11) Types of steam locomotives for local and light railways (especially narrow-gage lines); compounding and superheating, the use of other fuels beside coal, Mr. Von Littrow, Trieste, and Mr. Helmpel, Bavaria. (12) The use of motor cars on railways, and especially on local lines, Mr. E. A. Ziffer, Vienna. (13) The importance of the development of central or interior districts by means of local railways operated by electric traction, Mr. O. Petri, Nuremberg.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in Chicago on Jan. 22, the subject for discussion was a paper on "The Wrought Compressive Member for Bridge Trusses," which had been read by Mr. Horace E. Horton at a previous meeting. Mr. Armstrong (C. & N. W. Ry.) opened the discussion, and remarked that tests of full-sized columns are not essential to the design of large truss members. In his opinion, the defects in the design of the Quebec bridge were not due to a lack of knowledge in this direction, but rather to a failure to apply the knowledge already available. The details of members are of great importance, but full-size tests would not give much information as to detailing. There is, in fact, very little published information which will assist an engineer in designing the details of large modern structures.

Mr. Bainbridge (C. & N. W. Ry.) in a written discussion, also took the view that experimental tests of columns are desirable, but not, he considered, absolutely necessary as a basis for design. Such a test in itself would prove little, but the tests should be based on the methods employed by the Austrian Society of Engineers in testing elastic arches. They determined the strength analytically and proved by their tests not that the mathematical investigation was true, but that it was applicable in practice to elastic arches. He took exception to Mr. Horton's statement that two or more plates forming the sides of a compression member, properly riveted together, are not mutually supporting. Nor did he approve of the proposal to adopt for compressive unit stress an intensity only ¾ as great as that for tension. The proportioning of tension members is an easy matter, but a higher degree of knowledge and skill are required in proportion to a compression member so as to develop the maximum strength of the material. Mr. Prichard has proposed to proportion the lacing of compression members for a load equal to 3% of the total stress in the column (treated as a lattice girder) but this seems to be excessive. By this method, the lacing on the heaviest lower chord section of the Quebec bridge had a strength equal to only one-fifth of 1% of the stress in the column. Mr. Horton has proposed for the lacing a strength of between 5% and 25% of the stress in the column. The strength of a lacing bar should not exceed that of its riveted connections. Of the well-known impact formulas of Schneider and Prichard he preferred the latter, as it makes a reduction in impact for ballasted-floor spans. He did not think that specifications based on the use of impact formulas are open to the objection of introducing a multiplication in the number of unit stresses. There is practically only one unit stress for tension, one for compression, one for shearing and one for bearing. Exceptions to this are the provision for combinations of stress, which are not often operative.

Mr. Horton expressed his opinion in favor of the testing of models, and referred to the test of a quarter-size model of the Britannia tubular bridge in England, many years ago. He thought that if such a method had been adopted in regard to the Quebec bridge, the members would certainly not have been built as designed. There is little experimental and definite knowledge of the action of steel in built-up compression members, the strength being determined by the weakest elementary unit and the want of cohesion in the parts. He considered that the enclosed box section will probably be developed when maximum sections are required, the work of making connections being facilitated by the use of manholes in the cover plates. Such a section offers greater possibilities of connection than enclosed triangular or circular sections. Batten plates should be as near as practicable to the ends of the member; and cover plates, batten plates and latticing in vertical plane should be able to sustain the member in a horizontal position, acting as the web of a girder supported either at the ends or at the middle.

A resolution was adopted, on motion of Mr. Horton, to the effect that a committee should be appointed by the society to compile information in regard to tests of full-sized compression members, this information to be published in the "Journal" of the society.

WESTERN RAILWAY CLUB.—At the meeting held at the Auditorium Hotel, Chicago, on Jan. 21, there was an exceptionally large and representative attendance, owing to the interest in the subject for discussion. Mr. S. P. Bush, General Manager of the Buckeye Steel Castings Co. (Columbus, O.), presented a paper on "The Car Wheel and Its Relation to the Rail and Car," in which he referred to the increase in wheel failures and the discrepancy in the relations of the modern 700-lb. wheel under a 50-ton car and the old 525-lb. wheels under 12-ton cars. The total increase in the load which the present wheels have to carry is 240%, and the increase in brake pressure is 138%, while the weight of wheel has increased only 33%. The paper related mainly to flange breakages, which occur with both cast-iron wheels and steel wheels. Tests made at Purdue University showed a breaking strength of 47,000 lbs. to 111,000 lbs. for cast-iron wheel flanges under direct pressure, the average being about 60,000 lbs. A steel wheel required 526,612 lbs. pressure to break the flange. Mr. Bush, however, thought that very few cases of broken flanges were due to direct lateral thrust between the wheel and the rail. In tests at 36 miles per hour on a 4° curve, the maximum recorded pressure against the rail was 12,80[illegible] lbs., but undoubtedly the actual pressures in service may exceed this considerably. He estimated that wheels removed on account of flange failures represent 50 to 85% of all wheels removed.

The theory advanced by Mr. Bush was that the weight is transmitted to the rail on a narrow line of contact, just behind the wheel flange, or near the edge of the rail. This is particularly the case on curves, and frequently heavy loads are carried for some time in this way. These conditions may be aggravated by the heating of the wheel due to the application of the brakes, the brakeshoe bearing heavily near the side of the flange. The theory is supported by the fact that under such conditions seams might be caused, and in many cases the fractures show evidences of such seams. Comparatively few fractures occur from the flange being worn thin and broken off laterally through the smallest section across the base of the flange. By far the larger number come from the development of a seam opening vertically into the tread (just where the tread and fillet join) and then diagonally outward to the back of the wheel. This may occur with both iron and steel wheels, the peening action of the concentrated pressure being greater probably with the steel than the iron. While steel wheels may be better than iron in some respects, he did not consider that their use would be a remedy for present conditions. He advocated a modification of the wheel section with a fillet radius of ½-in. (instead of the present ⅝-in. standard, which is usually worn to ½-in. or less); this ½-in. fillet is connected to the tread by a short curve of 1½-in. or 2-in. radius. The tread would conform to the rail head, and then taper off to the outer face of the wheel by a curve instead of a flat coned surface. He considered that this would give a better relation between the rail and wheel, with a wider area of contact and a consequent elimination of the present tendency to severe concentration of load. His general conclusions were summarized as follows:

1, The matter of improving the quality of the wheel is a work that must necessarily go on. 2, Avoid the concentration of load by the use of a more satisfactory relation between the contour of the wheel and that of the rail. 3, Avoid the concentration of heat at or near the flange of the wheel by a modification of the brake practice. 4, Relieve the oftentimes existing high pressures against the flange by introducing the feature of lateral motion in truck construction, so that a considerable yielding resistance will be offered instead of an abrupt one. 5, For the purpose of avoiding the excessive wear of wheel flanges of all kinds, modify the contour and provide means whereby the resistance to the pivoting of the truck and of the wheels to track may be very materially reduced.

An animated discussion carried the meeting along till 11 p. m. Mr. Schroyer (C. & N. W. Ry.) expressed belief in the cast-iron wheel, and did not think it had ever yet received a "fair show." The weak point is admittedly the flange, but breakages have not increased in such proportion to the increase in loads as to indicate that the cast-iron wheel has reached its limit of usefulness. Failures are largely confined to the wheels of certain makers and wheels under certain classes of equipment, which is evidence that defects are in material and manufacture rather than in the wheel design. Mr. Hennessey (C., M. & St. P. Ry.) said that in his experience there were fewer flange failures now than 35 years ago, and he thought that makers should guarantee their wheels against any class of failure.

Mr. Barnum (C., B. & Q. Ry.) considered that the number of sharp-flanged wheels could be greatly reduced by reducing the friction in center and side bearings of freight cars. The ratio of wheels removed for sharp flanges to the total number of wheels removed ranges as follows on different roads: Freight cars, 48 to 62%; locomotives and tenders, 29 to 41%; passenger cars, 12 to 31%. A written discussion by Mr. Garstang (C., C., C. & St. L. Ry.) gave the flange failures as 0.15 to 0.17% of the wheels in service on his road. He considered the present standard form of wheel to be satisfactory, but thought that any change from the ⅝-in. fillet radius should be for a larger radius rather than the ½-in. proposed by Mr. Bush.

Lengthy discussions were made by Mr. Fowler (Consulting Engineer) and Mr. Griffin (Griffin Wheel Co.). The former described the tests made by him with cars on railway track, and referred to the nosing action of cars; this in some cases causes higher stresses in the wheel flanges when on tangents than when on curves. It is very evident that few realize the severe stresses to which wheels and trucks are subjected in actual every-day service. Mr. Griffin dealt with the difficulties of making wheels to comply with the requirements of the railways, and remarked that the present tendency to heating and concentration of stress near the fillet should be avoided. Owing to the lateness of the hour, it was voted to continue the discussion at another meeting.